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Canada - Saskatchewan Renewables — Conservation Demonstration Program

Final Report

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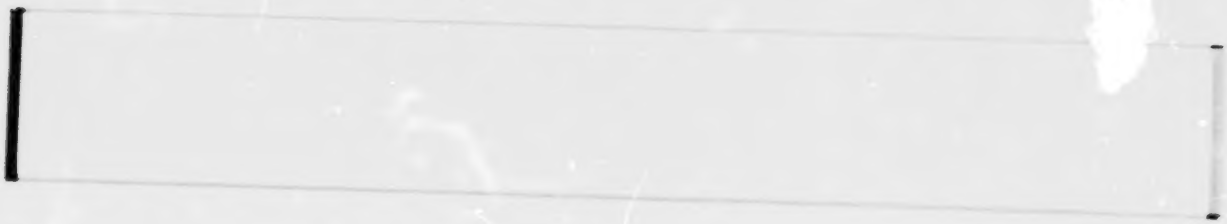

CANADA-SASKATCHEWAN CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

On March 18, 1980, the governments of Canada and Saskatchewan entered into a Conservation and Renewable Energy Demonstration Agreement. The Agreement, which terminates March 31, 1984, funds the development and demonstration of a wide range of conservation and renewable energy technologies. The program is funded on an equal cost-shared basis by Canada and Saskatchewan, and is administered by Saskatchewan.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies which exploit renewable energy resources, conserve energy, or make its use more efficient;
- To create employment in new or existing industries;
- To develop broad public awareness of the potential of renewable energy and energy conservation technologies.

This report outlines the results of a project funded by the Government of Saskatchewan as represented by Saskatchewan Energy and Mines, and the Government of Canada as represented by Energy, Mines and Resources Canada, under the terms of the Renewables-Conservation Demonstration Program, and contracted with the party identified herein.

However, neither the Government of Saskatchewan as represented by Saskatchewan Energy and Mines, nor the Government of Canada as represented by Energy, Mines and Resources Canada, accept liability for any errors, omissions, or inaccuracies that may; be included in or derived from this report, nor do they assume any liability with respect to the use of, or actions resulting from the use of, any information contained in this report.

Farm Energy Management Program

Phase One Report
on a Renewables-Conservation Demonstration Program Project

Conducted By

The Saskatchewan Research Council
Saskatoon, Saskatchewan

And Supported By

Saskatchewan Energy and Mines
and
Energy Mines and Resources Canada

Project Leader: Ewen Coxworth

Miscellaneous
Report FP-4

Miscellaneous
Report FP-4

EXECUTIVE SUMMARY

This report describes the beginning stages of a farm energy management study of 21 farms located throughout Saskatchewan. A description of each farm is given. Data is presented about energy use (fuel, electricity, fertilizer) in terms of where it is used (farm operations, transportation, and domestic use) and how energy costs relate to total costs. Projections are made as to what energy costs might be in 1986 if no energy conservation measures were undertaken between now and then.

The farms vary a great deal in where energy is used, in size, in type of farming operations, and in the type and amount of energy conservation measures already being tested or in place. The farmers are all united in their interest in various aspects of energy conservation and in improving the efficiency of energy use.

Some preliminary recommendations about energy conservation strategies have been made for each farm. These are very general since the program of assessing exactly where energy is being used is just commencing on each farm. We stress that accurate measurement and record keeping of all aspects of major energy use, and the relation of energy use to food production, are just being started. The overall program will be attempting to design energy conservation activities for each farm to improve the efficiency of energy use per unit of food production, and ultimately to reduce the impact of energy costs on Saskatchewan farms.

ACKNOWLEDGEMENTS

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G. Zoerb, Agriculture Eng. Dept., University of Sask.
W. Brown, Agriculture Economics Dept., University of Sask.
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1. INTRODUCTION

. OVERVIEW ON ENERGY SAVINGS AND ENERGY EFFICIENCY IMPROVEMENTS ON THE FARM

. MAJOR OBJECTIVES OF THE FARM ENERGY MANAGEMENT PROGRAM

Energy conservation has become an important factor in attempts to maintain economic prosperity as energy prices rise. Some recent examples are the following:

- Japan has had 7 years of essentially zero energy growth, yet has maintained an average economic growth rate (GDP) of 4% per year.

- In the European Economic Community during 1973-1978, it was estimated that 95% of new energy to achieve economic growth was obtained via energy conservation and only 5% via new energy supplies.

- The Saskatchewan Power Corporation (SPC) estimated that the average household used 16% less natural gas in 1980 (adjusted for a mild winter) than the yearly average in the period 1970-1975. Internally SPC has cut gas usage by 30%.

- Saskatchewan agricultural demand for direct energy (primarily liquid fuels) has decreased every year since 1976. There was a 12% reduction between 1976 and 1979 (Moroz, 1982)*.

- A recent Ontario agriculture energy study concluded that this conservation trend can continue. The study predicted that a 35% reduction was possible in tractor fuel and fertilizer energy needs for unit of crop production by the year 2000. An estimated 50% reduction in transportation energy costs was also considered possible.

* A second estimate (Gayton, 1982, Office of Energy Conservation, Dept. of Mineral Resources) indicates a slow rise in liquid fuel use from 1971 to 1979, followed by an 8% decrease to 1981.

The Saskatchewan farm energy management program is part of this world wide trend. It is aimed at finding and demonstrating short term energy conservation possibilities, and encouraging the long term trend to improved efficiency of use of energy for food production. Hopefully, the program will find ways to reduce the cost-price squeeze that many farmers find themselves in at the present time.

The overall objectives of the farm energy management program are:

1. To measure the energy use at the present time on 21 cooperating farms in terms of:

   a) where energy is used and in what amount: e.g. gasoline, diesel fuel, heating oil, electricity, fertilizer*.

   b) the time of the year when various forms of fuel are used, e.g. when are the peaks in diesel fuel use?

   c) with liquid fuels, to further subdivide fuel use down to specific unit operations: e.g. discing, harrowing, baling hay, grinding feed grains, hauling grain, etc., in order to identify the relative magnitude of different fuel uses as an aid to considering the importance of various conservation measures.

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* Indirect energy use, as in nitrogen fertilizers, has been identified as an important factor in other studies. Nitrogen fertilizer (made from natural gas) can become the major energy cost in intensive farming.
Chemicals (principally herbicides) are an important dollar cost, but their energy impact is low, i.e. their use is not usually an important energy item. We have not planned to measure their energy cost in this study. Dollar costs can be measured, since in some innovative practices, e.g. zero or minimum tillage, fuel energy savings are being somewhat offset by increased dollar costs of herbicides.

2. To aid in measuring energy use, and in testing the effectiveness (cost, dollars and energy saved, payback times) of various conservation techniques, we need to do the following things:

a) provide suitable record keeping books for each liquid fuel end use (each truck, car, tractor)

b) install fuel meters on all farm fuel storage tanks, including slip tanks used for field re-fueling.

c) test, evaluate and then install fuel monitors on major gasoline using equipment on each farm: private cars, half ton trucks, and perhaps on some gasoline using field equipment (e.g. tractors, combines) to:

i) provide a check on record keeping books

ii) to test the effectiveness of instant feedback monitors in reducing fuel consumption.

iii) to test the cost effectiveness of such on board monitors

iv) to provide more accurate fuel consumption data than from the record books based on the "filling the tank" approach.

d) for diesel equipment (mainly large tractors and big trucks) monitors are more costly and need more testing. The plan is to purchase several types, have them evaluated by research groups (for example, the Agricultural Engineering and Crop Science Departments, University of Saskatchewan, and the Agriculture Engineering Group, Agriculture Canada, Swift Current Station). Based on these initial results (provided results come fast enough), we would plan to purchase perhaps one diesel monitor per farm to be installed on a large tractor, to measure fuel use

per unit operation, and test various energy-saving options (e.g. gear up-throttle down).

e) electrical meters would be installed to distinguish between various electrical energy types: e.g., hog barns (fans, heaters, and lights), home, machine shop, farmstead, irrigation pumps.

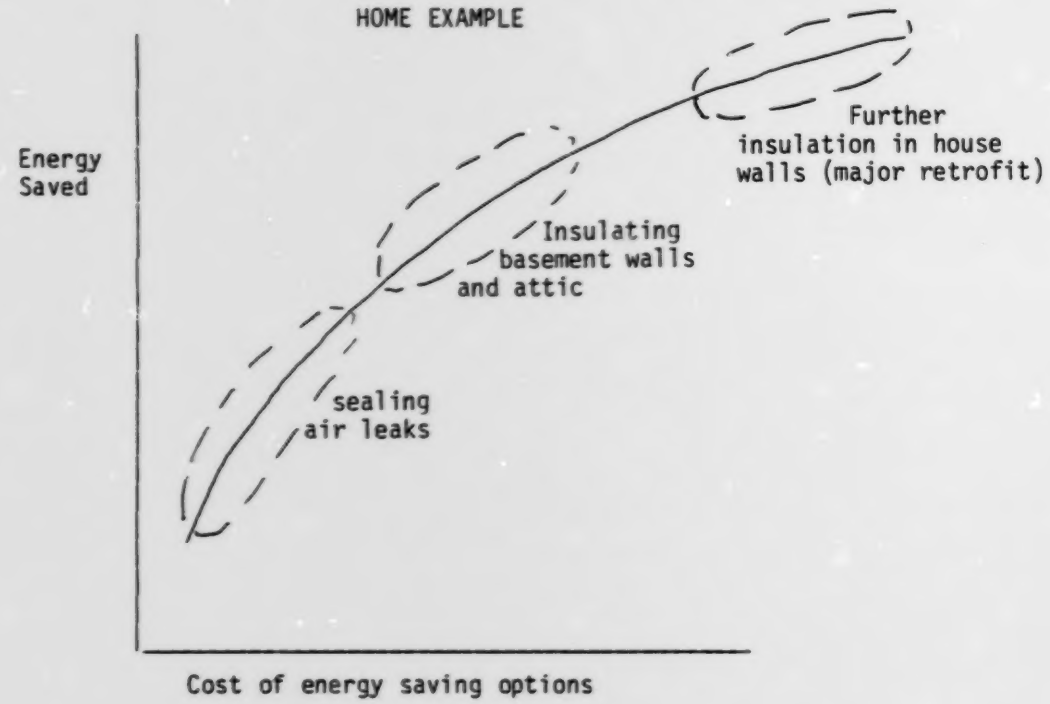
3. To test and implement the effectiveness of various energy (and dollar) saving options we need to:

a) know approximate present use

b) cost of conservation techniques., e.g. house retrofit, fuel monitors, equipment replacement, cost of minor options (e.g. tuning up motors, cleaning filters, keeping tires at the correct pressure).

c) identify the conservation options with the best pay back times.

The following figure illustrates that often the first major savings may be relatively cheap, and that the last 10% saved may be expensive (often not worth it at today's interest rates).


HOME EXAMPLE
Energy Saved
Further insulation in house walls (major retrofit)
Insulating basement walls and attic
sealing air leaks
Cost of energy saving options

d) what other people have done (e.g. Michigan study, house studies, crop technique savings)*.

4. Another important category in the study is the testing of techniques which increase yields of crops relative to investment in fuel and fertilizer. Probably the best example of this is snow management, where a very small dollar and energy cost, e.g. an attachment on the swather to leave 1% of the land with a snow trapping strip of tall stubble or uncut crop, may substantially increase yields (and dollar returns); and indirectly, reduce the energy consumption per unit of food output.

As an example, suppose a hypothetical 486 hectare (1200 acre) farm in the dark brown soil zone with:

- 162 ha (400 ac) summerfallow
- 162 ha (400 ac) wheat on summerfallow
- 162 ha (400 ac) wheat on stubble.

This farm will be used for testing various conservation options.

1) Test barrier strips on both summerfallow** and cropped areas (i.e. all the land at the end of the season).
2) Assume 200 kg/ha (3 bu/ac) increase in crop on summerfallow, i.e. 1680 kg/ha (25 bu/ac) increased to 1880 kg/ha (28 bu/ac).
3) Assume 400 kg/ha (6 bu/ac) increase in crop on stubble, i.e. 1000 kg/ha (15 bu/ac) increased to 1410 kg/ha (21 bu/ac).

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* The references at the end of the report include mention of a number of previous studies on energy conservation.

** Care has to be taken with increasing snow trapping on land than will be fallow the next year to avoid increasing soil water movement leading to increased soil salinity.

Abbreviations: ac = acres
bu = bushels
ha = hectares
kg = kilograms

This is in line with data from Lindwall, Steppuhn, Black and Siddoway (see references at the end of this report).

We have assumed wheat @ $183/tonne ($5/bu) (actual prices ranged from $184 to $206/tonne according to newspaper quotations in the first half of 1982). Potential (optimistic case) dollar benefits from snow management would be estimated as follows:

Crop	No snow trapping	With snow trapping	Benefit
Wheat on summerfallow	(1.68 x 183 x 162)= 25 x 5 x 400 = 50,000	(1.88 x 183 x 162) 28 x 5 x 400 = 56,000	(0.2 x 183 x 162= 3 x 5 x 400 = 6,000
Wheat on stubble	(1.00 x 183 x 162)= 15 x 5 x 400 = 30,000	(1.41 x 183 x 162)= 21 x 5 x 400 = 42,000	(0.4 x 183 x 162)= 6 x 5 x 400 = 12,000
Totals ($)	80,000	98,000	18,000

Note: No increase in fuel energy and little or none in fertilizer energy costs. In practice there would likely be a slight increase in combine fuel costs to thresh the slightly heavier crop. We assume a farm in the brown or dark brown soil zones, or drier years in black soil areas.

To emphasize: for a very low energy and dollar investment, we have gained $18,000 more income (and 98 tonnes (3,600 bushels) more food). This measure (assuming it is successful) has one of the best paybacks in term of net energy, i.e. better food energy yield after deducting energy costs. In times of financial uncertainty and hardship, energy efficiency improvements with low capital investments seem most likely to be implemented.

* Some reviewers felt that the yield benefits estimated here are very optimistic. Furthermore such snow trapping yield benefits might only be achieved if there was inadequate rainfall during the growing season. According to Montana studies (Black and Siddoway, 1976) winter wheat yields increased more with snow trapping than did spring wheat yields.

The savings shown above might be increased further if one or more fall tillage operations could be eliminated, (Lal and Steppuhn, 1980). This might save as much as \$10/ha x 162 ha (\$4/ac x 400 ac) = \$1,600 [Custom rates quoted by the local agriculture representative for a heavy duty cultivation were in the range of \$6.60 to \$9.10/ha (\$2.70 to \$3.70/ac)]. These savings would be reduced if a fall herbicide spraying was required to compensate for the weed control effects of the fall tillage operation.

5. Other savings related to cropping practices.

5.1 Legumes (pulse crops, forages, green manure crops) in the rotation occupy a less favorable, but probably still positive saving. In this case the main effect we are striving for is to maintain yield, and substitute biologically fixed nitrogen for some of the purchased nitrogen fertilizer. Can this save money? From one study (Boerma, Gimby and Coxworth, 1980) of a wheat-wheat-fallow rotation at Indian Head (black soil zone) the nitrogen fertilizer savings were estimated for the use of sweet clover, in the following rotation: Year I: wheat on summerfallow → Year II: wheat on stubble; underseeded with sweet clover → Year III: sweet clover plowed down early in June, followed by summerfallow the rest of the growing season → Repeat Year I] The conclusion of this study was that the use of sweet clover as a nitrogen source, saved \$12.00 per hectare per annum (about \$4.85/ac).

This saving was that observed over all the hectares in the rotation, including those in summerfallow. The savings were in comparison to costs of production on control plots which used relatively low rates of fertilizer.

Applied to the 486 hectare (1200 acre) farm in our example, this would give a dollar saving of (486 x 12) = $5,830.

Several cautions seem in order in talking about sweet clover use. In the study at Indian Head, in the years prior to 1977 the yields of wheat obtained in the rotation using sweet clover were very similar to those obtained in comparison plots using commercial nitrogen fertilizer. However, the rates of nitrogen fertilizer used until 1977 were relatively modest (6.2 kg N/ha and 23.7 kg N/ha for wheat on summerfallow and stubble respectively). When the nitrogen fertilizer rates on the comparison plots were increased in 1977-1979 to 7.5 kg N/ha and 72.7 kg N/ha, on summerfallow and stubble respectively, wheat yields and net income were distinctly higher than on those plots using sweet clover as the only fertilizer source. Research would be needed to test the yields from various combinations of sweet clover and commercial fertilizer use. Furthermore, it seems to be generally accepted that sweet clover use in rotations can seriously deplete soil moisture, particularly in the dark brown and brown soil zones. Thus using sweet clover as a green manure crop may be restricted to the black soil zone with present technology. Improved snow trapping might enable sweet clover to be used in the dark brown soil zone, but experiments would be needed to confirm this.

Legume seed crops, e.g. field peas, lentils, faba beans, might also help save nitrogen fertilizer energy costs, if they were included in crop rotations. The major savings would probably be in reduced nitrogen fertilizer demands for the legume seed crop, although in some cases there might be nitrogen fertilizer benefits for the following crop.

One of the major methods to increase efficiency of energy use related to fertilizer, might be in the use of improved methods of employment of commercial fertilizer. Beaton (1980) has recently reviewed methods to improve the efficiency of fertilizer use in western Canada. These methods include timing, method of placement, form of applied nitrogen, control of nitrification and urease activity, and combinations of nitrogen with other fertilizer nutrients.

Beaton has also reviewed present fertilizer use in western Canada and projected possible requirements for the future. To meet a production target of 54 million tonnes of grains and oilseeds for 1990, would require about 2,482,000 tonnes of nitrogen fertilizer. This compares with 591,000 tonnes used in 1979 (Beaton, 1980). Thus a 4.2 fold increase in nitrogen fertilizer use could be expected in a little over a decade. According to Gayton (1982) Saskatchewan farmers used about 7 PJ of energy as nitrogen fertilizer in 1979 (roughly 145,000 tonnes according to Beaton, 1980). A 4.2 times increase would mean the use of about 609,000 tonnes (29.4 PJ) of nitrogen in 1990. In energy terms 29 PJ is nearly as much energy as was used as liquid farm fuels (gasoline and diesel) in 1979, when total farm fuel use amounted to 34.5 PJ (Gayton, 1982).

Rennie (1978) has reviewed the rate of loss of soil nitrogen since western Canada has been settled. About 42 kg nitrogen per hectare per year has been released from soil organic matter, with about 14 kg nitrogen sold off the farm (as the protein in the wheat, for example), the rest being lost to leaching, denitrification, and erosion. To replace this nitrogen on all the 16.2 million cultivated hectares would require

650,000 tonnes of nitrogen fertilizer, roughly the same as the amount calculated by Beaton (1980) to meet the 1990 increased food production goal.

5.2 Zero tillage can drastically reduce fuel use for tillage and greatly reduce soil erosion. The dollar savings may be less due to the high cost of herbicides (Zentner and Lindwall, 1978).

5.3 Thus the dollar savings (or net yield gains) could be ranked roughly as follows:

SUMMARY OF SAVINGS AND COSTS

Crop Management Practise	Net Energy Gains	Dollar Savings and/or Income Gains	Cost	Risk of Yield Loss If Poorly Done
1. Snow management	High	High	Low	Low
2. Legumes in the rotation (sweet clover green manure).	Medium	Medium	Medium	High in brown & dark brown soils.
3. Zero tillage	High	Low	High	High
4. Eliminate last fall tillage	Low to Medium	Modest	Low (depending on extra herbicide needs)	Low

This ranking is similar to farmers' comments at MEXibition in Saskatoon: Snow management was eagerly and positively discussed, legumes had some adherents and some doubters, while zero tillage had many doubters and only a few people trying it (those who not tried this technique mentioned the cost of chemicals, plus some farmers were concerned about

health and environment risks)*. Most farmers felt that equipment operation savings or space heating type savings were not large, or else were expensive.

6. How do these crop practice savings compare with costs and savings in home and barn energy use conservation, and in the choice and use of cars, trucks, tractors, combines and other powered farm equipment? We will employ the acreage and crop pattern described on page 5-6, based on the farm used in the MEXibition example (1981) to test this, and as a basis for developing a strategy of energy conservation planning and implementation. The sample farm is a mixed grain-hog production operation situated close to the boundary of the black and dark brown soil zones. The energy budget of this farm was reported several years ago (Jensen, 1977). We assumed the same area and rotation as before (items 4 and 5) but a much lower snow management benefit ($5,000 instead of $18,000). The results are shown in Table 1.1 on the next page.

Note that half of the projected energy savings are related to snow management yield increases, and 28% are related to space heating savings in barns. These two measures cost approximately $3,000 and save (or gain profit in the case of snow management) in the range of $8,000 per year, i.e. the payback time is well under one year.

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* Nonetheless, zero or minimum tillage has been widely accepted in parts of the United States, probably in part because of dramatic reductions in wind and water soil erosion resulting from adoption of these techniques.

Table 1.1 A Rough Estimate of Possible Energy Related Savings on a Mixed Grain-Hog Farm (Edge of Black and Dark Brown Soil Zones)

Item	1981 Costs ($)	Amount and Type of Savings	Amount Saved ($)	Investment Cost
I CROP PRODUCTION				
(a) Diesel fuel for tractors and combines	3,925	10%: maintenance, gear up-throttle down; wheel slip adjustment, Eliminate 1 tillage operation (fall)	400 *	Low
(b) Gas for trucks	2,733	(i) 10%: reduce speed, wind baffles, fewer trips. (ii) buy diesel trucks (save 30%)	300* 800-900	Low High but will occur as vehicles must be replaced Incremental extra costs, est. $5,000
(c) Nitrogen fertilizer	3,684	(i) 20-40% ? with legumes-very situation dependent. (ii) Improved efficiency of use of purchased fertilizer.	700*-1,500	Moderate-depends on present N fertilizer rates, risk of drought loss Some indication that better placement of fertilizer can improve efficiency considerably.
(d) Snow Management	? 500 for swather attachment(?)	Increase yield relative to fuel and fertilizer costs.	5000*	Low - the location of the farm, e.g. black, dark brown, brown will affect possible benefits from snow management greatly.
(NOTE: if 1% of crop left uncut, losses would be $800)				
(e) Electricity for shops	38	not a large item		
II LIVESTOCK (Pork: 60 sow herd)				
(a) Diesel fuel for tractors	1,281	10% as above I (a)	130*	Low
(b) Gas for trucks	2,733	(a) 10% as above I (b)(i) (b) 30% as above I (b)(ii)	300* 800	Low High, with comments as in I (b)(ii)
(c) Electricity for barns	3,104	(a) 25% assuming 1/2 is used for lights and fans (no savings); 1/2 used for heating, 1/2 of which is saved by insulation and heat exchangers.	800*	Est. 2,000 (insulation 800, air to air heat exchanger 1,200).
(d) Heating Oil	3,024	75%: assuming insulation and heat exchangers added	2,200*	Borne by II (c)
III HOME AND PERSONAL				
(a) Gasoline (cars)	3,572	(i) 10%: maintenance, driving speed, tires, schedule trips. (ii) 35%: purchase 1982 car to replace (say) 1974 bigger one. Assume 30 mpg rel. to 20 mpg (road use)	400* 1,200	Low, some nuisance costs. High (8,000-12,000/car) but will be needed as present cars wear out.
(b) Electricity	530	10%: via timers on heaters, yard lights, reduce wattage of lights, replace old stoves and fridges.	50*	Low to moderate: best policy on major appliances to shop for energy efficient models as needed. If the house has an electric water heater, could use shower savers, reduce hot water temp. - savings are obviously modest.
(c) Heating oil	1,510	(a) <25%: tighten doors, windows, cracks In attic, basement insulation etc., furnace tune up. (b) 50%: major retrofit	400* 800	Est. 1,000, depending on basement insulation state. 10,000+ the cost of wall retrofit drives up the incremental cost of next 25% energy saved very fast. Probably has low priority unless house needs to be rebuilt anyhow.
Total present costs	$26,134			
Savings assuming the most cost effective and lower cost items done (marked*):			$10,680	

In other words, 75% of the reduction in energy costs relative to food production (i.e. including yield gains relative to fixed fuel and fertilizer investment) are related to two measures which have low or relatively low cost investments.

Most of the other measures are relatively small in their dollar savings, and vary greatly in their cost effectivness. Major car and (perhaps) truck purchases, as they are done for replacement reasons, can have substantial savings in fuel costs.

7. Conclusions:

The cropping practices techniques described are being tested by some FarmLab participants. After discussions with soil scientists, the most effective way to include these factors in our study is to include some 3-4 farms in our study from FarmLab*. We will measure the energy dollar implications of the experiments, while University of Saskatchewan agriculture scientists plan and manage all the agricultural aspects of the experiments. In this way both major studies gain information and each group specializes as originally planned. We are not involved in planning agricultural experiments; we merely collect the necessary data to show the energy savings, or net energy gains of the experiments set up by others.

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*This has now been done. A description of FarmLab is given in Appendix C. Descriptions of the FarmLab experiments on the farms in our group will be given in the year 2 report.

For other energy savings, e.g. home and barn heating, vehicle use, cultivation methods, etc., we will examine each farm, and attempt to identify the most cost effective conservation measures to implement and/or to test, given the financial restrictions farmers are facing now. In many cases, it may be a situation of putting into place modest cost and energy saving measures now. As money is available, or as vehicles must be replaced, or as buildings are given major renovations or replaced, there will be opportunities for major energy savings at relatively modest costs*.

8. The world needs more food. Can Saskatchewan increase its food production and still keep energy costs reasonable so that food costs remain competitive in world markets? (Improvements in energy efficiency might also reduce inflation related to food production). It seems possible from this modest overview that this might be achieved.

Perhaps as far as liquid fuels are concerned an achievable goal might be 30% more food production with no increase in farm fuel energy consumption.

Fertilizer energy costs are likely go up if Western Canada aims at increased food production per unit of land. How much it increases would depend on such factors as improved efficiency of ammonia production (underway), improved efficiency in the use of fertilizer, and possible inclusion of nitrogen fixing legumes in crop rotations.

As far as the personal energy uses of the farmer and his family are concerned, a 30% energy reduction seems a reasonable goal in the next 5-

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* Various government programs exist to help reduce costs of different conservation options. We will help farmers take advantage of these programs.

10 years, as cars are replaced, and improvements are made in home space heating efficiency.

THE FIRST PHASE OF THE STUDY (YEAR 1)

In the following sections of the report we have described the specific aspects of the first seven months of the project. We have worked with the individual farmers to obtain a detailed inventory of energy use on each farm. This inventory is to be used as a base for exploring possible energy conservation measures. The first general comments about possible energy conservation possibilities for each farm are given. These will be used as a basis for discussions with individual farmers in order to work out a specific plan for each farm.

2. METHODS

2.1 Concepts used in Farm Energy Audits

One of the most important and difficult decisions in designing a farm energy audit program concerns which energy inputs to include in the analysis. Some researchers convert all farm inputs to an energy basis including machinery, buildings and chemicals. Others include only the direct energy components of fuels and electricity. Either approach may be considered correct if it obtains the information needed for a particular study.

The concept used in this project was to include in the energy audit those farm inputs which will be most affected by rising energy costs. These are fuels, electricity, and fertilizers.

Another basic decision was that energy used in the farm home and for personal transportation should also be accounted for in the energy audit. The rationale for this approach is that a dollar saved by conservation measures for the family car is just as significant to the farmer as a dollar saved in tractor operation. The audit format used in this project is shown in Appendix B.

2.2 Energy Conversions

In order to calculate the energy content of the farm energy inputs, published energy values were adopted.

a) Direct Energy

For fuels, higher heating values were adopted; for electricity, its direct heat equivalent (Table 2.1).

Table 2.1 Energy Content of Fuels and Electricity

Energy input	Energy Content *	Source
. diesel fuel	38.7 MJ/ℓ	(1)
. motor gasoline	34.7 MJ/ℓ	(1)
. light fuel oil	38.7 MJ/ℓ	(1)
. propane	25.6 MJ/ℓ	(2)
. natural gas	37.2 MJ/m^3	(1)
. wood (oven-dried)	20. MJ/kg	(3)
. electricity	3.6 MJ/kWh	(1)

Source: (1) Statistics Canada (1978)
(2) Kent (1954)
(3) Love (1980)

b) Embodied Energy

For fertilizers, values for the actual fuel used in their production were adopted (Table 2.2).

*Abbreviations: mj = megajoules (10^6 joules)
ℓ = litres
m = metres
kg = kilograms
kWh = kilowatt hours

Table 2.2 Energy Content of Fertilizers

Energy Input		Energy Content (MJ/kg)	Source
Anhydrous ammonia	(82-0-0)	47.3	(1)
Urea	(45-0-0)	32.7	(1)
Ammonium nitrate	(33-0-0)	23.8	(1)
Aqueous ammonia	(20-0-0)	11.8	(1)
Mono ammonium phosphate	(11-48-0) (11-55-0) (11-55-0)	14.2	(2)
Ammonium nitrate phosphate	(23-23-0)	19.2	(2)
Ammonium nitrate phosphate	(25-25-0)	21.5	(2)
Ammonium nitrate phosphate	(27-27-0)	25.0	(2)
Ammonium nitrate phosphate	(34-17-0)	26.0	(2)

Source: (1) Southwell and Rothwell (1978) (AFC-values)

(2) Adapted from (1) by the authors.

2.3 Energy Price Forecasts

To highlight the significance of foreseeable increases in energy prices on farm energy costs, energy cost forecasts were prepared for 1986 for each farm. Recent price decreases in liquid fuels (May, 1982) have not been included in this report. Corrections will be made in future reports.

a) Direct Energy

Forecast fuel and electricity prices are estimates based on discussions with official sources. The price of wood, assumed to be available on the farms where it is used at the cost of harvesting it, was arbitrarily set at \$0.01/kg (\$0.50/GJ)* to get it on the record. This requires further investigation. The prices are displayed in Table 2.3.

Table 2.3 Forecast Fuel and Electricity Prices for 1986. (Average 1981 prices for comparison)

Energy Input	Unit	Mid-year prices (current dollars per unit) 1981	1986	Average annual increase (%)	Source
Diesel Fuel - clear	ℓ	0.37	0.82	17	(1)
- purple**	ℓ	0.28	0.64	18	(1)
Motor Gasoline-clear	ℓ	0.37	0.76	16	(1)
-purple**	ℓ	0.29	0.62	16	(1)
Heating Oil	ℓ	0.25	0.56	18	(1)
Propane - clear	ℓ	0.24	0.47	14	(1)
- purple**	ℓ	0.20	0.39	14	(1)
Natural Gas	m^3	0.11	0.20	13	(2)
Electricity	kWh	0.034	0.085	20	(2)
Wood (oven-dried)	kg	0.01	0.01	0	(3)

Source: (1) Saskatchewan Mineral Resources, personal communication
(2) Saskatchewan Power Corporation, personal communication
(3) Arbitrarily set.

* GJ = gigajoules (10^9 joules)
**= reduced price (tax exempt) for farm use (prior to May, 1982).

b) Embodied Energy

Average bulk fertilizer prices paid by the cooperating farmers in 1980 (Table 2.4) were broken down into two components: energy, and non-energy.

The energy component of the price was calculated on the basis of the energy content of the fertilizer (Table 2.2), assuming a 1980-dollar value for this energy of \$2.42/GJ (equivalent to \$0.09/m^3 for natural gas). This energy component of the cost was then escalated to 1986 at an annual rate of 12.5 percent, slightly lower than the rate forecast for the retail natural gas price (Table 2.3).

The non-energy component of the fertilizer price - the balance - was escalated to 1986 at an annual rate of 10%, assumed to represent the general inflation rate.

The results are displayed in Table 2.4.

Table 2.4 Forecast bulk-fertilizer prices for 1986. (Average 1980 prices paid by farmer cooperators for comparison)

Fertilizer		Price (current cents per kilograms) 1980 actual	1986 forecast
Anhydrous ammonia	82-0-0	37	69
Urea	45-0-0	24	45
Ammonium nitrate	33-0-0	15	28
Aqueous ammonia	20-0-0	11	20
Mono ammonium phosphate	11-48-0 11-51-0 11-55-0	25	46
Ammonium nitrate phosphate	23-23-0	22	40
Ammonium nitrate phosphate	25-25-0	23	42
Ammonium nitrate phosphate	27-27-0	24	44
Ammonium nitrate phosphate	27-14-0	25	46

The prices for fertilizers quoted in Table 2.4 are the total prices for the fertilizers and includes raw materials, labour, return on investment and profit. Nitrogen fertilizer is given the main emphasis in terms of improved efficiency of use since its manufacture is much more energy intensive than phosphorus or potassium (see Jensen and Stephanson, 1975, for example). Total costs are quoted (e.g. for 11-48-0) since it is impossible to separate N-P-K costs, in dollars or joules, when buying or applying a compound fertilizer.

Costs of nitrogen fertilizer, in dollars per unit of energy to make the fertilizer, are not much different from the cost of liquid fuels such as gasoline or diesel fuel. According to Tables 2.2 and 2.3, anhydrous ammonia costs \$7.82 per gigajoule (\$7.82 GJ^{-1}). This price includes the raw material cost (natural gas) plus labour, profit, etc. Similarly, from Tables 2.1 and 2.3, clear diesel fuel costs \$9.56 GJ^{-1} and purple diesel fuel \$7.24 GJ^{-1} (prices as of March, 1982). These prices include raw material cost (crude oil), but they also include refinery costs, wholesale and retail profits, and taxes to federal and provincial governments. Thus Jensen (1982) has calculated that over 50% of the retail price of gasoline consists of royalties and federal and provincial sales taxes and charges. Similarly to nitrogen fertilizer, the purchaser can't separate the true energy cost from the other costs when he attempts to save money by saving on fuel. Therefore, throughout this study, we have used the price paid by the farmer for an energy intensive material, such as diesel fuel, gasoline, heating oil, or nitrogen fertilizer, as the energy cost we are trying to manage, conserve, or improve the effiency of use.

All charts and graphs thus report the total retail price of the energy intensive input being studied.

2.4 Farmer Selection

Farmer participants were chosen from lists of names provided by several sources. These sources included SRC (farmers who have participated in previous studies), Sask. Dept. of Agriculture, University of Saskatchewan (FarmLab Participants), Jensen Engineering, and Farm West Management Ltd. To date a total of twenty-one farmers have been chosen to participate in the program. These farmers have gained a reputation for being innovators in their communities and many are graduates of the University of Saskatchewan college or school of agriculture.

An attempt was made to have the farms more or less evenly distributed throughout the six agriculture regions. The actual distributions is as follows:

Agricultural Region	No. of Farms per Region
Northeast	4
East Central	3
Southeast	3
Southwest	3
West Central	4
Northwest	4

The types of farms chosen are as follows:

8 straight grain	1 mixed grain and market garden
5 mixed grain and cattle	1 mixed grain and dairy
3 mixed grain and hogs	1 dairy
1 mixed grain and sheep	1 cattle ranch

Four of the cooperating farmers are FarmLab participants.

2.5 Farm Visits and Inventory

Each farmer participant was visited to:

1. explain the aims and objectives of the project.
2. obtain the data required to prepare a detailed inventory of his energy consumption.
3. record all relevant information regarding his current farming practices and potential changes he could make.
4. identify the monitoring equipment required for each farm.

2.6 Computer Data Base

A computer data base (program EDTFRM/LSTFRM) was set up for each farm. The data base contains information on the location, soil, topography, area and land-use. Further, it contains an inventory of livestock heated buildings, fuel tanks, farm production equipment, transportation equipment, and energy-using equipment in the farm home. The data base has been set up to allow for adding additional items, as well as detailed records on energy use, when these become available during Phase II of the project. The data base is also intended to serve as a working file, from which data will eventually be extracted for presentation in suitable formats, and to aid in simulation of energy management options for each farm.

Specific computer programs are available from other organizations (e.g. the University of Saskatchewan) to calculate the economic effects of specific changes in farm practises. Discussions have been initiated to use these programs in subsequent phases of this project, where such programs seeem appropropriate.

2.7 Farm Energy Use and Cost in 1980

Energy use and energy cost in 1980 for each farm were analyzed using the energy values displayed in Tables 2.1 and 2.2, as well as the following information supplied by the farmer cooperators:

- Quantities of fuels, electricity and fertilizers used
- Unit costs for each energy input, if available (if not available, unit costs were assumed)
- The farmer's estimated distribution of each energy input among farm production, transportation, and domestic uses.
- Total farm expenses.

A computer program (ERG) was written which calculates energy content and cost of each energy input, total direct energy input, total embodied energy input, and total energy input.

It also calculates the fractions of the total energy cost attributable to the production, transportation and domestic sectors.

Finally, it calculates the cost contribution of each energy input as a fraction of the total energy cost, the energy content contribution of each energy input as a fraction of the total energy content of the inputs and the cost of the direct and embodied energy costs as a fraction of the total farm expenses.

2.8 Farm Energy Cost Forecast for 1986

The energy cost for each farm in 1986 was forecast, using the forecast prices displayed in Tables 2.3 and 2.4 and assuming no change in energy inputs as compared to 1980.

2.9 Preliminary Analysis of Conservation Options

Study of the farm descriptions and inventories together with the results of the energy use and energy cost analysis enabled the project team to identify a number of areas of potentially major energy cost savings for most farms. This identification is necessarily somewhat tentative as - in general - the farmer cooperators do not have detailed records of energy end uses on their farms. More specific recommendations will become possible after the fuel metering program is initiated in Phase II.

3. RESULTS

3.1 Farm Data Presentation

The Phase I results are summarized in Table 3.1.

The Phase I results for each farm are presented in Appendix A. They consist of:

a) A listing of the location, soil, topography, land area, livestock inventory, heated buildings, a description of the cropping practices, and livestock enterprise*.

b) A graphical summary of energy use and energy cost distribution on the farm in the form of four pie-charts. The data for constructing the pie-charts were calculated as described in Section 2.7. These charts present, clock-wise from bottom left:
   1. energy content by fuel (incl. electricity and fertilizer);
   2. energy cost by fuel;
   3. energy cost as percentage of total expenses broken down as direct energy (fuels and electricity) and embodied energy (fertilizer);
   4. energy cost by sector (production, transportation, domestic).

c) A comparison of 1980 actual energy cost (retail purchase price) with the forecast 1986 energy cost in the form of a bar chart. The data for constructing the bar charts was calculated as described in Sections 2.7 and 2.8.

d) A listing of the conservation options identified for the farm as described in Section 2.9.

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* An inventory of equipment and fuel tanks has been done, and summarized on computer print-out sheets for each farm. It is not included in this report for the sake of brevity. The information is on file at SRC.

Table 3.1 Summary of the Farms Studied

General Operation	Size	Location	Soil	Energy Cost by Type (% of total spent on energy) D Diesel	G Gasoline	H Heating Oil	P Propane	N Natural Gas	W Wood	E Electricity	F Fertilizer	Energy as % of Total Expenses D Direct Energy	E Embodied Energy	O Other Expenses	Energy Costs % by Sector P Production	T Transport	D Domestic	Comments
1. Straight Grain																		
A) Conventional Rotations	# 3 Med.	E.C.	D Br	30	27			7		6	30	18	8	74	61	28	11	5 cows only
	# 5 Med.	S.E.	Br	9	23	5				8	55	13	16	71	75	18	7	Typical st. grain
	#14 Med.	S.W.	Br	15	22					7	56	21	25	54	74	20	6	Typical st. grain
	#16 Med.	W.C.	Br	22	21	6				4	46	17	15	67	71	21	8	Typical st. grain
	#18 Large	W.C.	Br	21	25			3		3	48	14	14	72	74	23	3	Typical st. grain
	#20 Small	W.C.	Br	5	29			3		3	60	7	10	83	69	26	5	Op. also does off-farm work.
			Avg:	17	24.5							15%	14.7%	70.2%	70.7%	22.7%	6.7%	
			Field Fuel:	41.5% Heating 4.0%						Elect. 5.2%	Fert. 49.2%							
B) Extended Rotations	# 8 Large	N.W.	BK	16	9	2				1	72	8	21	71	88	11	1	4 yr rotation
	#15 Large	S.E.	D Br	13	13		7			5	62	8	13	79	85	2	3	4 yr rotation
			Avg:	14.5	11							8%	17%	75%	86.5%	11.5%	2%	
			Field Fuel:	25.5% Heat 4.5%						Elect. 3%	Fert. 67%							
2. Mixed Farm																		
A) Conventional Rotations	# 7 Med.	E.C.	BK	21	38	7				8	26	27	10	63	54	36	10	2 yr rot. + hogs
	# 9 Small	N.W.	D Br	15	48	19				18	--	19	--	81	20	48	32	2 yr rot. + sheep
	#13 Small	E.C.	D Br	7	25	11				39	19	9	2	89	72	22	6	Hog & beef mainly
	#17 Med.	S.W.	Br	14	27	8				10	41	20	14	66	58	25	17	2 yr rot. (typical)
			Avg:	14.3	34.5							18.8%	6.5%	74.8%	51%	32.8%	16.3%	
			Field Fuel:	48.8% Heat 11.3%						Elect. 18.8%	21.5%							

General Operation	Size	Location	Soil	Energy Cost by Type (% of total spent on energy) D Diesel	G Gasoline	H Heating Oil	P Propane	N Natural Gas	W Wood	E Electricity	F Fertilizer	Energy as % of Total Expenses D Direct Energy	E Embodied Energy	O Other Expenses	Energy Costs % by Sector P Production	T Transport	D Domestic	Comments
B) Extended Rotations	# 1 Med.	N.E.	BK	14	8	2	6			3	67	6	12	82	93	5	2	300 Feeders custom op.
	# 2 Large	E.C.	BK	16	22	6	2			6	49	10	10	80	73	19	8	1/2 beef & grain, 25% S.F.
	# 4 Med.	W.C.	D Br	11	16	1	2			7	63	10	17	73	79	16	5	Continuous with herbicide, innovations, etc.
	# 6 Med.	N.E.	BK	9	16	2				5	68	10	21	69	81	14	5	~ 1/6 cultivation as S.F.
	#12 Small	E.C.	BK	23	45	12				17	3	14	--	86	32	43	25	Continuous cropping
			Avg:	14.6	21.4							10%	12%	78%	71.6%	19.4%	9%	
			Field Fuel:	36%		Heat 6.6%				Elect. 7.6%		Fert. 50%						
3. Ranching																		
	#19 Med.?	S.W.	Br	11	65	10	1			13	--	10	--	90	30	50	21	Cow-calf to feed out (some off-feed purchase
			Field Fuel:	76%		Heat 11%				Elect. 13%		Fert. 0%						
	Could also include #13 (Beef-Hog op.)																	
4. Other Combinations																		
A) Conventional Plus market garden	#11 Small	N.W.	BK	34	51				4	11	--	30	--	70	38	48	14	2 yr rot. plust market garden (30 mi. to market.)
			Field Fuel:	85%		Heat 4%				Elect. 11%		Fert. 0%						
B) Dairy Op. (Continuous Crop)	#10 Small	S.W.	Br	20	31					49	--	4	--	96	65	19	16	Continuous cropping (Feed grain & forages)
			Field Fuel:	51%						Elect. 49%		Fert 0%						
Dairy Op. plus 3 or 4 yr grain	#21 Med.	W.C.	BK	16	40					17	28	10	4	86	69	28	3	3 to 4 yr rot.
			Field Fuel:	56%						Elect. 17%		Fert. 28%						
	Could also be included in Mixed Extended Rotation group.																	

definitions adopted:

Farm size: < 1000 acres: small, 1000 - 2000 acreas: medium, > 2000 acres: large
Rotations: 2 - 3 yr: conventional, over 3 yrs: extended rotations.

General Comparisons	Energy Cost by (%)				% of Total Expense			% by Sector		
	Field Fuel	Heating	Elect.	Fert.	Direct	Embodied	Other	Production	Transport	Domestic
1. Straight Grain (8)										
A) Conventional Rotations (6)	42	4	5	49	15	15	70	71	23	7
B) Extended Rotations (4 yr) (2) (No continuous cropping in survey or near equivalent)	26	5	3	67	8	17	75	87	12	2
Observations	Energy 25-30% of total expense of which 70-80% + utilized in production phase. Extended (not approaching continuous cropping) shift energy % proportion from field fuel to fertilizer input (larger farm extended rotations appear to direct more into the production phase).									
2. Mixed Farm (Livestock - grain) (9)										
A) Conventional Rotations (4)	49	11	19	22	19	7	75	51	33	16
B) Extended Rotations (5) (nearly to continuous cropping)	36	7	8	50	10	12	78	72	19	9
Observations	Mixed farming tends to lower energy expense (20-25%) of total due to added livestock capital expenses. Relative increase in % of energy used in field fuel consumption & sometimes in heating i.e. baling, grinding & heated barns. Tend to use a lower % in fertilizer but show some emphasis shift as above (1) for continuous cropping.									
3. Ranching (1)	76	11	13	0	10	-	90	30	50	21
Observations	Energy low in total expenses - stock replacement costs, off farm feed, equipment, transport, etc. Field fuel use & transport high - i.e. baling, grinding, feeding, transport, etc.									
4. Other Combinations (4)										
A) Grain (conventional) + market garden	85	4	11	0	30	-	70	38	48	14
B) Dairy (continuous feed-grain & forages)	51		49	0	4	-	96	65	19	16
C) Dairy plus extended rot. grain	56		17	28	10	4	86	69	28	3
Observations	Market garden appears to be high in field use & transport to markets, as % of total expense. Similar to other st. grain or mixed farming operations i.e. no apparent high sp equip capital Dairy operations show energy input low compared to capital in special equipment costs.									

(Compiled by A. Rutherford)

3.2 Identified Conservation Options

A. General recommendations are as follows:

1. For all farms, it is recommended that meters be installed on all fuel tanks to allow accurate measurement of existing fuel use patterns and to allow measurement of the impact of changes in operation on the use of fuels.
2. For all farms, it is recommended that existing aerial photographs be analyzed to check for possible improvements to field efficiency. Aerial photos should be helpful in identifying energy losses due to inefficient field configurations, work patterns, fertilizer and herbicide misses and overlaps.

B. Specific recommendations for each farm were developed by the project team and are listed in Appendix A along with other data for each farm.

3.3 Data Quality

Emphasis should be placed on some of the limitations of the data.

Some of the data, such as the distribution of energy use among the major farm sectors, are based on estimates supplied by the farmer cooperators.

Further, the data collected to date is incomplete. Some information, such as fuel inventories, could not be collected within the Phase I time constraints. A very substantial amount of information, such as trip records and hours and fuel expended on field operations, is not available partially because farmers do not usually keep such records. However, in many instances, such as fuel use for specific operations, the farm simply is not equipped to measure the data required.

4. CONCLUSIONS

4.1 Potential for Energy Cost Savings on Farms

The sample of farms contacted provided data regarding energy uses and costs which were analyzed. The results of this preliminary analysis appear to support previous studies showing potential for energy savings in several areas. Significant potential for energy cost savings exists on most of the farms studied.

The major areas of savings may be categorized into the following groups:

1) Transportation - appeared to offer considerable potential for significant energy savings in a fairly short period of time across a large number of the farms studied;

2) Cropping practices: energy savings appear possible in the following areas:

a. Fertilizer program - the largest use of energy on some farms

b. Crop rotation: i.e. legume use, improved efficiency of commercial fertilizer use by timing and placement.

c. Moisture management: Utilizing existing energy input levels more effectively by mitigating the first limiting factor in production on many farms.

Many of these practices would require small scale testing and several years evaluation before they could have a substantial impact.

3) Ancilliary practices: on certain farms, unique opportunities exist for significant energy conservation. These include such practices as grain handling, drying and storage; and manure storage and utilization.

4) Heated Buildings

a. Livestock buildings - significant opportunity exists for energy saving in the area of insulation improvement and in the potential for use of heat exchangers.

5) Farm Buildings

a. Farm home: -several homes on the study have been partially or completely retrofitted. Based on the age of many other homes on the 21 farms, we believe it is likely that a significant number would probably show potential for energy savings when they are examined by building energy experts. Such examination may be done depending on general energy conservation discussions with the farmers.

b. Shops and other buildings:- these were not, on the whole, large users of energy; however, on some individual farms, attention given to the shop energy use would be profitable.

6) Operation of Farm Machinery

There is very likely potential for tractor fuel energy savings by practices such as gear-up throttle-down. The magnitude of these savings probably varies considerably from farm to farm and/or vehicle to vehicle.

4.2 Farmers Response to Project

The highlight of the survey from a farm-management standpoint is the wide range of farm management styles represented in the sample. The project involved cooperators reflecting a wide cross-section of interests, goals, and operation types. A very wide range of farming methods is re-

flected in the sample, including relatively small, intensive farms as well as large extensive operations.

All of the farm managers involved expressed a positive attitude toward their participation in the project. When cooperators were being selected, even those who declined to participate did so because of circumstances in their situation which would have made accurate data collection difficult. This suggests that a very favourable environment exists for the technological transfer planned in Phases II and III of this project.

Interest in energy cost savings exists uniformly throughout the sample, regardless of soil zones, enterprise type, and managerial style.

4.3 Monitoring Requirements

Because of difficulties encountered in obtaining accurate data regarding fuel use, allocation of fuel, and machine use, it will be necessary to implement more precise monitoring techniques in 1982.

1) On-board monitors:

   If dependable models can be selected, on-board monitors should be placed on selected vehicles and machines. Their purpose would be to measure overall efficiency and fuel use as it relates to operator techniques, habit and "style". It would monitor the effectiveness of such practices as "gear-up: throttle-down", changing tillage depth, etc.

2) Dispensing meters and records:

   It was concluded that, to obtain reliable and useful data, accurate records of fuel use would be needed. This will involve placing a flow meter and a simple log book at each fuel tank. The log sheets will be mailed to SRC at the end of each month and processed.

The basic design requirements of the record system are:

a. easy to use, yet reasonably accurate;

b. mounted at each meter, complete with pencil, forms, and sharpener;

c. weatherproofed

d. mounted at shoulder height for ease of use.

The inventory of fuel on hand and fuel use to date would be entered at the time of meter installation.

Illustration 4.3.1.

Farm # _____ SAMPLE FUEL LOG SHEET

TANK I.D. DIESEL

Date	Vehicle or Machine	Hours or Km or Miles	Litres	Accumulated Litres	Jobs Done Job	Last Tank Hours or km
May 03	8640	1276	346	782	Cultivate	8.5 hr.
May 04	DUETZ	2106	76	858	Stone-Pick	6. hr.
May 04	Half ton	18020	64	922	Bought Parts	210 Km
	Half ton	18020	64	922	Personal use	300 Km

3) Additional electrical meters will need to be installed on some farms in order to accurately measure electricity use for certain enterprises. Saskatchewan Power has offered to assist with installation of these meters.

In all cases, the study will attempt to reconcile actual recorded fuel use to receipts for fuel purchases. Some difference is anticipated due to: evaporation and leakage, error in recording, theft, and refueling at service stations without recording it on the log. It is believed that accurate metering is required to ensure the accuracy of the data and to heighten the cooperator's awareness of fuel use. Previous studies have not incorporated stringent quality control on fuel use data, and it is believed that this is a crucial aspect of this study. All cooperators have agreed to attempt to use the logs diligently.

5. RECOMMENDATIONS

1. Farm energy audits based upon farm business records must be carefully designed and evaluated because the quality of data available from farm records varies widely between farm operators.

2. It is not possible to accurately allocate energy costs to various end uses on the farm based upon farm business records. Estimates of energy distribution without metering should be viewed with caution.

3. Meters should be installed to obtain reliable data on specific energy end uses where that information is desired.

4. We stress that our present lack of precise knowledge of energy use on these farms, particularly with regard to the distribution of use of liquid fuels, is a hindrance to planning energy conservation strategies with each of the farmers. This situation should improve greatly as meters are installed and records are kept for each type of fuel use.

We will also need to keep records of yields of crops so that energy use and energy conservation measures can be related to food production. Some farms appear to use remarkably less energy than others of about the same size and type of crops produced. Provided yields have not been sacrificed by these conservation measures, some of the energy conservation practices of these farmers could be of interest to other farmers, particularly those with similar soil conditions and type of farm operation.

Further discussions will be needed with farmers and agricultural scientists to determine whether certain types of conservation measures can be implemented without sacrifice of yield. For example, some farmers appear to use many more deep tillage operations on summerfallow than do

other farmers. Is this a reflection of different types of soil conditions, or can some of these deep tillage operations be eliminated?

In many cases, the first year's results indicate that energy consumption needs to be related to end use operations and units of production:

i.e. - energy costs per weanling pig produced;

- fuel costs per mile or kilometer driven,

- fuel oil costs for home heating per unit floor area (e.g. per square foot or per square meter),

- propane costs per bushel of grain dried per a stated number of moisture units removed,

- tractor fuel costs per acre or hectare of harrowing, seeding, spraying, etc.

Again, these types of energy measurements can best be done when we arrange for recording and metering the energy costs of different activities.

The first year's results reported herein should thus be regarded only as a general picture of energy use on these 21 farms. Enough information has been gathered to give us a general guide for future discussions with each farmer concerning energy conservation measures to consider.

6. FUTURE WORK PLAN

6.1 Work Plan For Phase II (April 1, 1982 - March 31, 1982)

In Phase II the farmer cooperators will:

1. record metered energy consumption;
2. review their energy audits and analyses;
3. select and implement conservation alternatives.

The project team will conduct technical and economic evaluation of selected conservation options to help each cooperator determine the payback periods of proposed changes. The forecast effects on his net income, cash flow, taxation and other farm management criteria will also be considered. Computer models developed in Phase I will be expanded to aid in these calculations.

TASKS

1. Visits will be made to each farm to discuss the output from Phase I and determine which conservation options the cooperator wishes to have evaluated. Meters will be installed on all fuel tanks and the record-keeping system will be initiated.

2. Air photos will be obtained and analyzed for each farm to identify energy losses due to inefficient field configurations, working patterns, fertilizer and herbicide misses and overlaps, etc. Initially, existing photos will be obtained from government sources (Saskatchewan Tourism and Renewable Resources). In mid-summer current photography will be obtained for each farm to supply infrared coverage for use in analyzing crop energy efficiency.

3. Farmers with heated barns and shops will be encouraged to have the buildings analyzed by the Energy Bus program operated by Office of Energy Conservation, Saskatchewan Mineral Resources. Regional Farmstead

Engineers will be consulted for general comments, and specific plans for changes and additions.

4. Manuals containing current energy conservation literature will be prepared in cooperation with Saskatchewan Agriculture and made available to each cooperator and other interested farmers.

5. Energy management strategies will be developed for each farm. Technical assistance will be obtained from Saskatchewan Agriculture, the University of Saskatchewan, other divisions of SRC, FarmLab, Agriculture Canada and other sources, to provide the most up-to-date information on conservation ideas.

6. Existing computer models will be used to simulate the energy-saving impact on cooperating farms in the project. Energy consumption in Phase I will be adjusted by the computer to determine how significant the proposed changes will be in both energy and economic terms.

7. Each cooperator will be visited again in mid-summer to review the metering program and discuss conservation progress. Fuel monitors will be installed on selected equipment to test their effectiveness for saving energy.

8. Energy end-uses will be determined by analyzing results of the metering programs. This will permit more detailed recommendations for energy conservation.

9. Each cooperator's progress in energy-savings will be evaluated on a case study basis to compare his energy consumption in Phases I and II. The metered results from Phase II will also show how accurately each cooperator estimated this distribution of energy costs to various end-uses on the farm.

10. Energy consumption on each farm during Phase II will be analyzed to prepare a record of seasonal energy demand.

11. An interim report will be prepared to summarize energy consumption and progress in conservation efforts on the cooperating farms during Phase II.

6.2 Work Plan For Phase III (April 1, 1983 - March 31, 1984)

Phase III will be a continuation of Phase II with increased emphasis on technology transfer. The project team will work closely with specialists in Saskatchewan Agriculture to design and implement an effective extension program to transfer the project results to the farming community of Saskatchewan.

TASKS

1. Technical assistance will be continued to help cooperators implement their selected conservation options.

2. Record-keeping procedures will be reviewed and modified if necessary, based upon results in Phase II.

3. Metered energy consumption in Phase II will be used to assess the efficiency of specific operations on the farms. (Examples include heating energy consumption per unit of floor area, tractor fuel use per acre cultivated, etc.). These analyses will assist in pinpointing energy losses on each farm, and will also provide a data base for extension use in discussions with other farmers.

4. Worksheets will be developed to assess energy conservation options on any farm. Results of the project will be used as examples in the worksheets. A suitable format will be developed in cooperation with Saskatchewan Agriculture so that the worksheets can be made available to all interested farmers in the province.

5. After sufficient testing to check the reliability of the worksheet procedures and assumptions they will be converted to computer format suitable for use by extension agencies.

6. A general computer model will be developed for energy analysis

of any farm in Saskatchewan. Input forms will be prepared for distribution by Saskatchewan Agriculture. Test runs will be made on a number of non-project farmers to determine the response to the service and the quality of output which can be derived from existing farm records.

7. Tours and seminars will be arranged for interested farmers to visit the project members and discuss their conservation programs.

8. Liaison will be maintained with the farm media to provide interviews, articles and other publicity for the project.

9. Energy consumption on each cooperating farm will be compared for the three years studied. Patterns and changes will be analyzed to assess the impact of the project.

10. A final report will be prepared summarizing the methodology of the project, the results achieved and the conclusions reached about the potential for energy conservation on Saskatchewan farms.

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APPENDIX A

FARM ENERGY AUDITS AND CONSERVATION OPTIONS

Note: Energy Cost Forecasts for each farm are graphed to different scales because of large differences in size (and energy costs) of the different farms.

: Readers are reminded that the liquid fuel costs and projections were made before the recently announced (May, 1982) price reductions.

FARM 1

FARM INVENTORY:	YEAR 1981	
REGION:	NORTH EAST	
SOIL ZONE:	BLACK	
SOIL TYPE:	MELFORT SILTY CLAY LOAM	
TOPOGRAPHY:	ROLLING	
TOTAL AREA:	1360 ACRES	551 HECTARES
CULTIVATED AREA:	1035 ACRES	419 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	FEEDER CATTLE	300

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOUSE	1973	1120 SF 104 m^2

Crop Production: An almost continuous cropping rotation is practiced on this farm with only about 1/8 of the entire crop land base summer fallowed in any given year.

The principle crops grown include: barley, wheat and canola. From 70 to 300 acres (28-121 ha) of barley is cut annually for silage.

The tillage and seeding operations for crops grown on stubble include:

- fall cultivation
- anhydrous ammonia application with cultivator
- spot incorporation of Avadex where needed with discer

- rod weed
- seeding
- post-emergence spraying

For Crops Grown On summerfallow:

- fall incorporation of Treflan with discer
- fall cultivation
- rod weed
- seeding
- post-emergence spraying

Summerfallow operations include:

- 6 or 7 times cultivate or rod weed. Fertilizer is applied according to annual soil test results.

A grain dryer is used almost every year.

Livestock Operation:

This farmer operates a custom feed lot.

The housing system consists of corrals and open sheds. Feeding is done out of bunker silos with silage loaded on to feed wagons with a front end loader. Milled barley is fed with the silage.

In 1981, 300 head were fed out using silage feed barley which was grown on the farm.

Finished cattle are hauled 200 miles (322 km) to market.

Each year the manure pack is custom loaded and spread on fields and then directly worked in. In 1981, approximately 100 acres (40 ha) had manure applied.

SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Review the manure management program; obtain and review manure analyses and soil analyses; and utilize the two in the fertilizer program.

2. Investigate the feasibility of legume silage.

3. Check for the possibility of high-moisture grain use in livestock feeding.

4. Monitor the energy effectiveness of the snow-trapping program*.

5. Arrange an energy audit of the shop by the Office of Energy Conservation.

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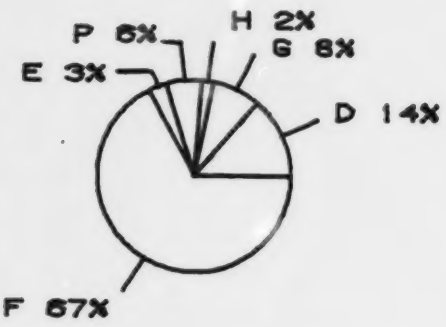
* Details of specific research and testing projects (e.g. FarmLab) will be given in the next report.

A5

FARMER'S ESTIMATED DISTRIBUTION

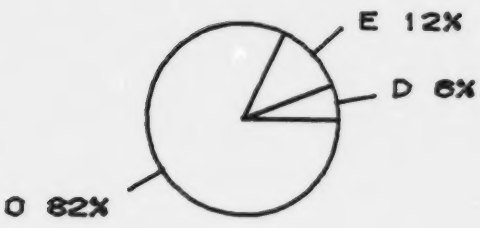
Year 1980 Farm No. 1 Energy Cost $ 34,468. Total Expenses $ 195,467

Energy Cost By Fuel



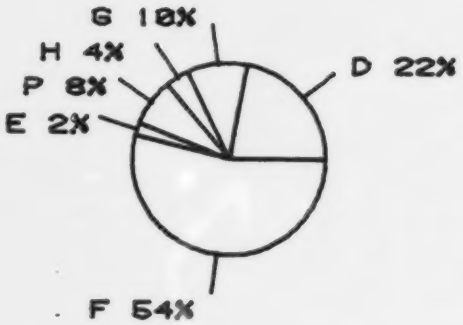
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

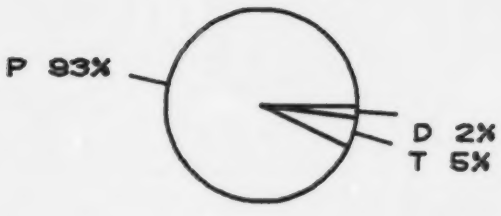


D = Direct Energy
E = Embodied Energy
O = Other

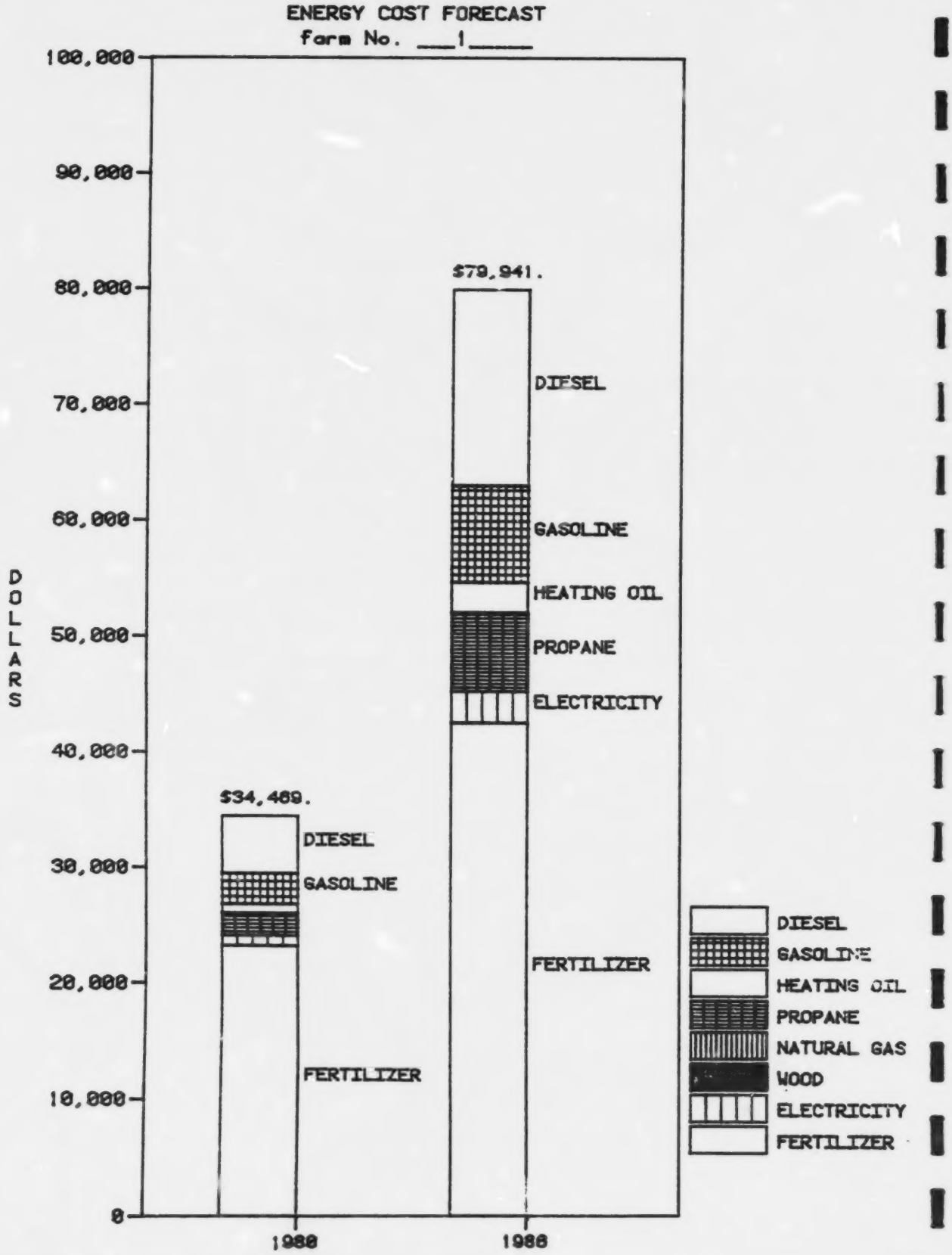
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
Farm No. ___1_____
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
DOLLARS
$79,941.
DIESEL
GASOLINE
HEATING OIL
PROPANE
ELECTRICITY
FERTILIZER
$34,469.
DIESEL
GASOLINE
FERTILIZER
1980
1986
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 2

FARM INVENTORY:	YEAR 1981	
REGION:	EAST CENTRAL	
SOIL ZONE:	BLACK	
SOIL TYPE:	WHITESAND SANDY LOAM	
TOPOGRAPHY:	ROLLING	
TOTAL AREA:	2240 ACRES	907 HECTARES
CULTIVATED AREA:	1040 ACRES	421 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	BEEF CATTLE	125

	ANIMAL	NUMBER
BREEDING STOCK:	BEEF COWS	116

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOUSE	1959	962 SF 89 m^2
	FARM TRAILER	1975	1188 SF 110 m^2

These farmers are moving towards more continuous cropping rotations with 25% of the cropped land area in summerfallow in any given year.

The principal crops grown include: wheat, canola, barley and oats. Each year 20 acres (8 ha) of the crop in oats is underseeded to clover and cut as hay the following year.

The tillage and seeding operations for crops grown on stubble include:

- deep tillage cultivation first thing in spring.
- anhydrous ammonia application.

- harrow.
- light duty cultivation.
- seed with press drill.
- spray for post-emergence weeds.

For crops grown on summerfallow:

- 2 x light duty cultivation.
- seed with press drill.
- post-emergence spraying.

Summerfallow operations:

- 2 x deep tillage cultivation.
- 3 x light duty cultivation.

Fertilizer is applied according to annual soil test results.

In some years the use of a grain dryer is necessary.

Livestock Operation:

A cow-calf operation with a breeding herd of 116 cows is maintained by this family.

The housing system consists of corrals and open sheds. Three barns are used in the spring for calving. Feeding is done using a front end loader and half ton. Baled straw and hay and feed barley is used for feed and bedding each year.

-(the hay crop consists of 20 acres (8 ha) of clover, 60 acres (24 ha) of brome, alfalfa and slough hay).

Each year the manure pack is loaded on trucks and dumped in piles on the field; then worked into the soil. In 1981 approximately 20 acres (8 ha) had manure applied.

Hogs and chickens are raised for personal use.

SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

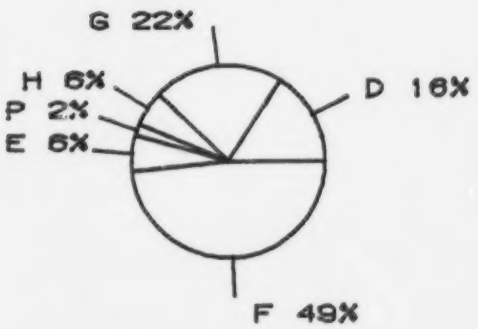
1. Analyze transportation fuel use and efficiency.
2. Review management of manure handling and distribution.
3. Review energy efficiency of combine at time of replacement.
4. Analyze possibility of use of legumes more extensively in the cropping and feeding programs.
5. Consider energy effectiveness of snow trapping.

A10

FARMER'S ESTIMATED DISTRIBUTION

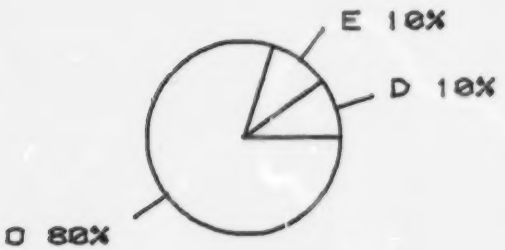
Year 1980 Farm No. 2 Energy Cost $ 20,549. Total Expenses $ 103,059

Energy Cost By Fuel



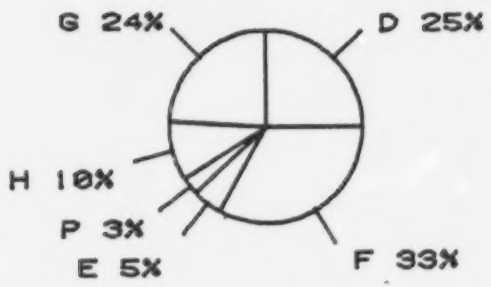
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

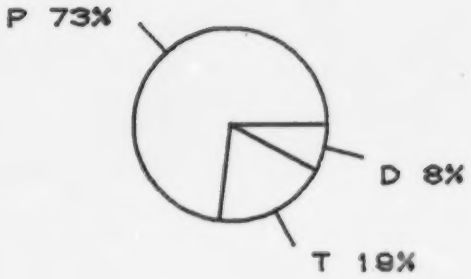


D = Direct Energy
E = Embodied Energy
O = Other

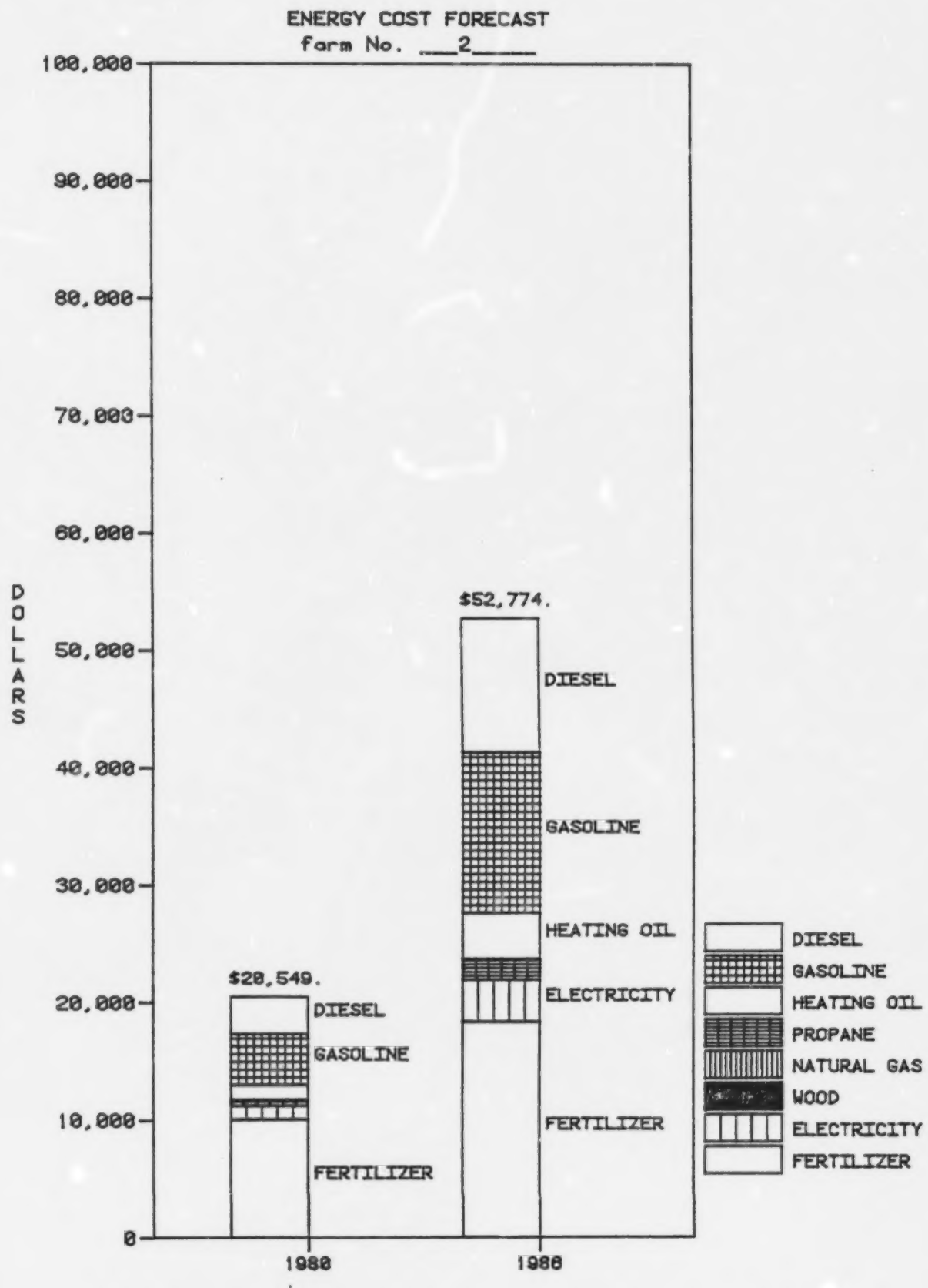
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
farm No. ___2_____
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
DOLLARS
$20,549.
DIESEL
GASOLINE
FERTILIZER
$52,774.
DIESEL
GASOLINE
HEATING OIL
ELECTRICITY
FERTILIZER
1980
1986
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 3

FARM INVENTORY:	YEAR 1981	
REGION:	EAST CENTRAL	
SOIL ZONE:	DARK BROWN	
SOIL TYPE:	ASQUITH LIGHT LOAM	
TOPOGRAPHY:	GENTLY ROLLING	
TOTAL AREA:	1600 ACRES	648 HECTARES
CULTIVATED AREA:	1225 ACRES	496 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	COWS	5

	ANIMAL	NUMBER
BREEDING STOCK:	COWS	5

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1976	1408 SF 131 m^2

Crop Production: A three-year crop rotation is practiced by this farmer with the amount of stubble cropped dependent on spring moisture conditions.

The principal crops grown include: wheat and barley.

The tillage and seeding operations for crops on stubble include:

- 2 x fall deep tillage cultivation.
- seeding with a hoe drill.
- 2 x harrow.
- post-emergence spraying.

For crops grown on summerfallow:

- deep tillage cultivation.
- seeding with hoe drill.
- post-emergence spraying.

Summerfallow operations:

- 5 x deep tillage cultivation.

Fertilizer is applied according to soil test results.

Livestock Operation:

A herd of five cows is maintained for children's 4H projects. Feed is purchased. Bedding and hay is custom baled.

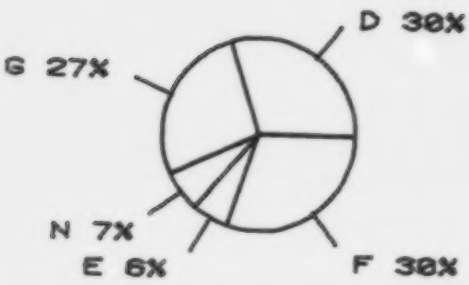
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Test "Gear-up: throttle-down" practices.
2. Monitor feasibility of snow management.
3. Consider energy effectiveness of vehicle propane conversion.
4. Arrange an energy audit of the shop by the Office of Energy Conservation Energy Bus.

FARMER'S ESTIMATED DISTRIBUTION

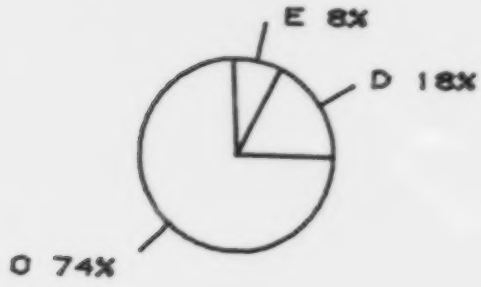
Year 1980 Farm No. 3 Energy Cost $ 9,001 Total Expenses $ 34,503

Energy Cost By Fuel



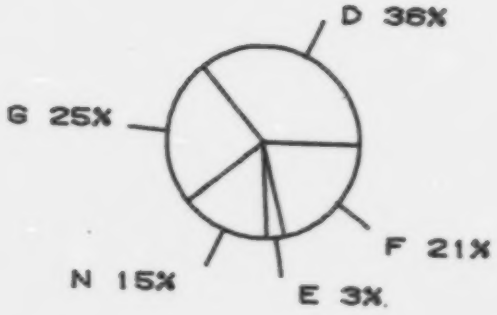
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

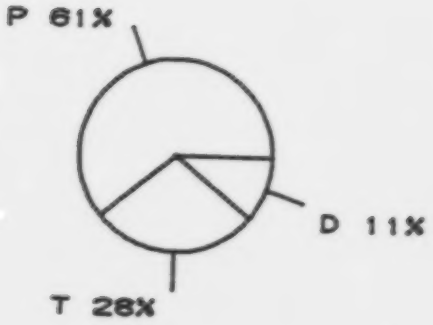


D = Direct Energy
E = Embodied Energy
O = Other

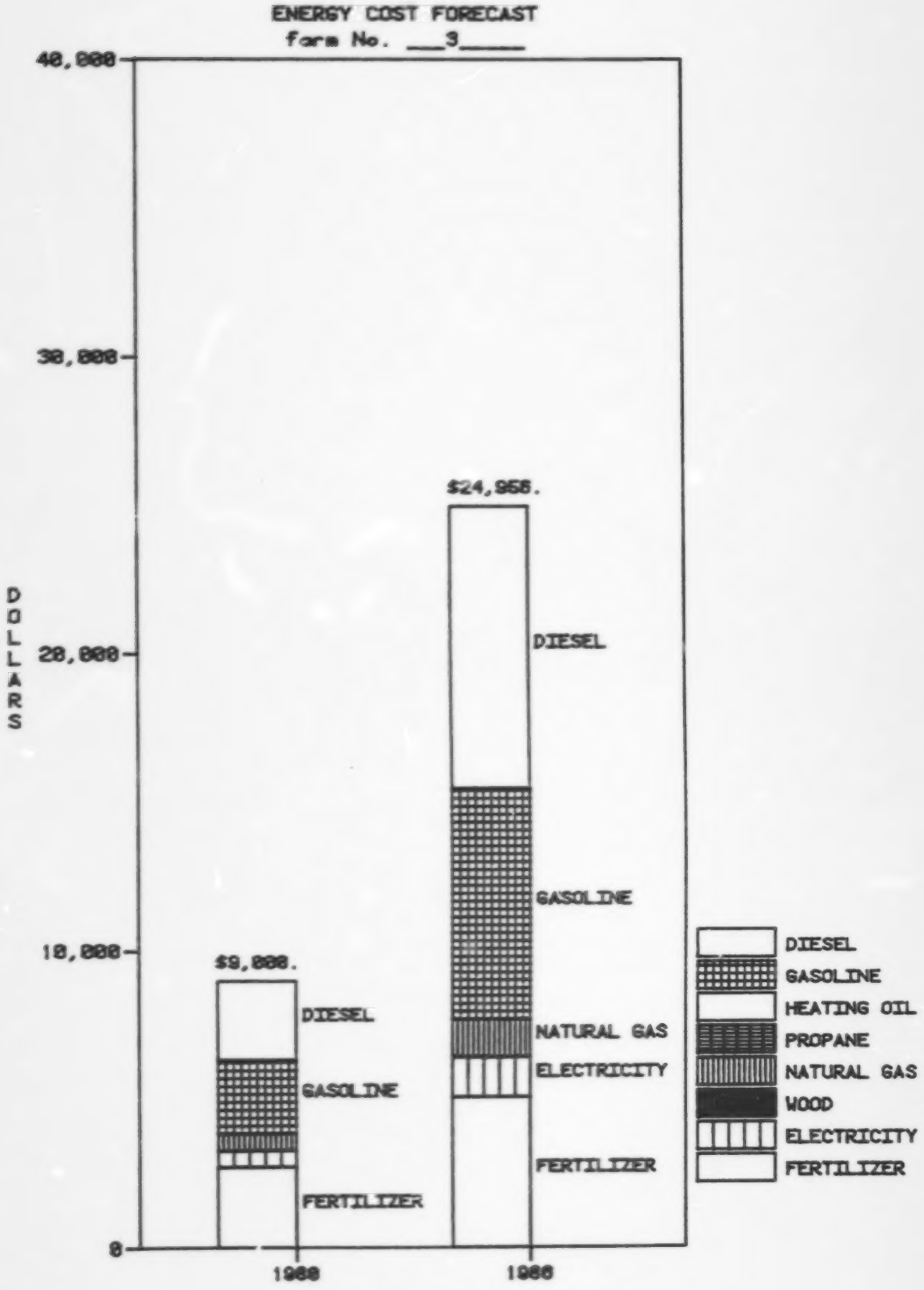
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
farm No. ___3_____
40,000
30,000
20,000
10,000
0
DOLLARS
$24,956.
DIESEL
GASOLINE
NATURAL GAS
ELECTRICITY
FERTILIZER
$9,000.
DIESEL
GASOLINE
FERTILIZER
1988
1986
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 4

FARM INVENTORY:	YEAR 1981	
REGION:	WEST CENTRAL	
SOIL ZONE:	DARK BROWN	
SOIL TYPE:	ELSTOW LOAM	
TOPOGRAPHY:	GENTLY ROLLING	
TOTAL AREA:	1760 ACRES	713 HECTARES
CULTIVATED AREA:	1740 ACRES	704 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	BEEF CATTLE	30
BREEDING STOCK:	COWS	30

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1978	2700 SF 251 m^2
	TRAILER	1971	792 SF 74 m^2

Crop Production: A continuous cropped zero till system has been used on the greater part of this farm for the past four years.

A side roll irrigation system is used to water 85 acres (34 ha) which is not zero tilled.

The main crops grown include: wheat, barley, canola and soft white wheat.

For the most part, tillage operations have been replaced with herbicide control of weeds. All of the crop is straight combined, then dried by a natural air drying system.

Fertilizer is applied according to soil test recommendations.

This farmer is a FarmLab co-operator.

Livestock Production:

A cow calf herd consisting of 30 brood cows is maintained on this farm.

The housing system consists of corrals, open sheds and a calving barn. Feed is prepared with a grinder mixer and pail fed. Barley, barley straw bales, slough hay bales and wheat straw bales are used for feed and bedding each year.

The manure pack is custom loaded and spread on the fields. Approximately 10 acres is worked in immediately after spreading each year.

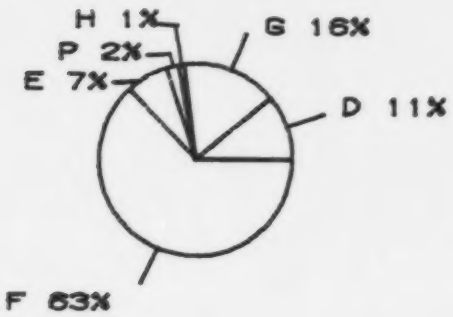
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Check energy efficiency of grain drying fans.
2. Assist development of on-going energy evaluation projects.
3. Analyze cropping program re: possible use of legumes (pulse crops).
4. Arrange an energy audit of the farm home by the Saskatchewan Research Council Housing Group.
5. Review transportation energy use.
6. Consider pump test on irrigation system.
7. Examine energy implications of on-going zero till system.
8. Analyze manure management.

FARMER'S ESTIMATED DISTRIBUTION

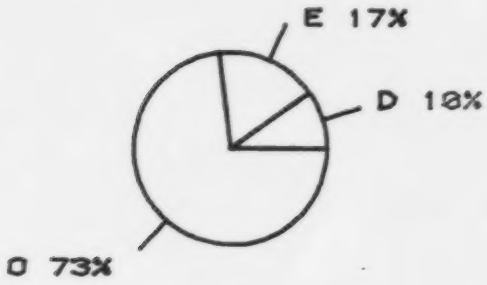
Year 1980 Farm No. 4 Energy Cost $ 34,369. Total Expenses $ 131,210

Energy Cost By Fuel



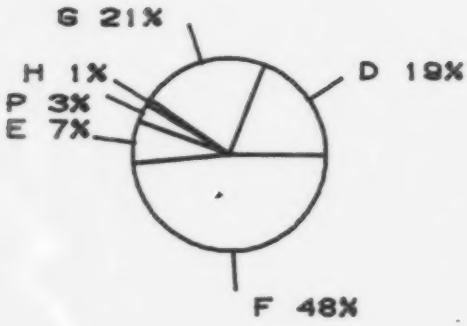
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

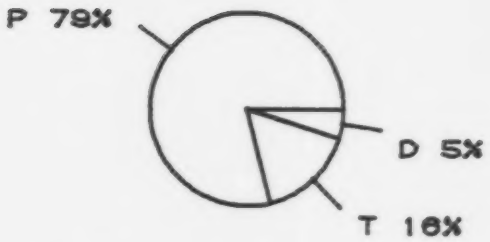


D = Direct Energy
E = Embodied Energy
O = Other

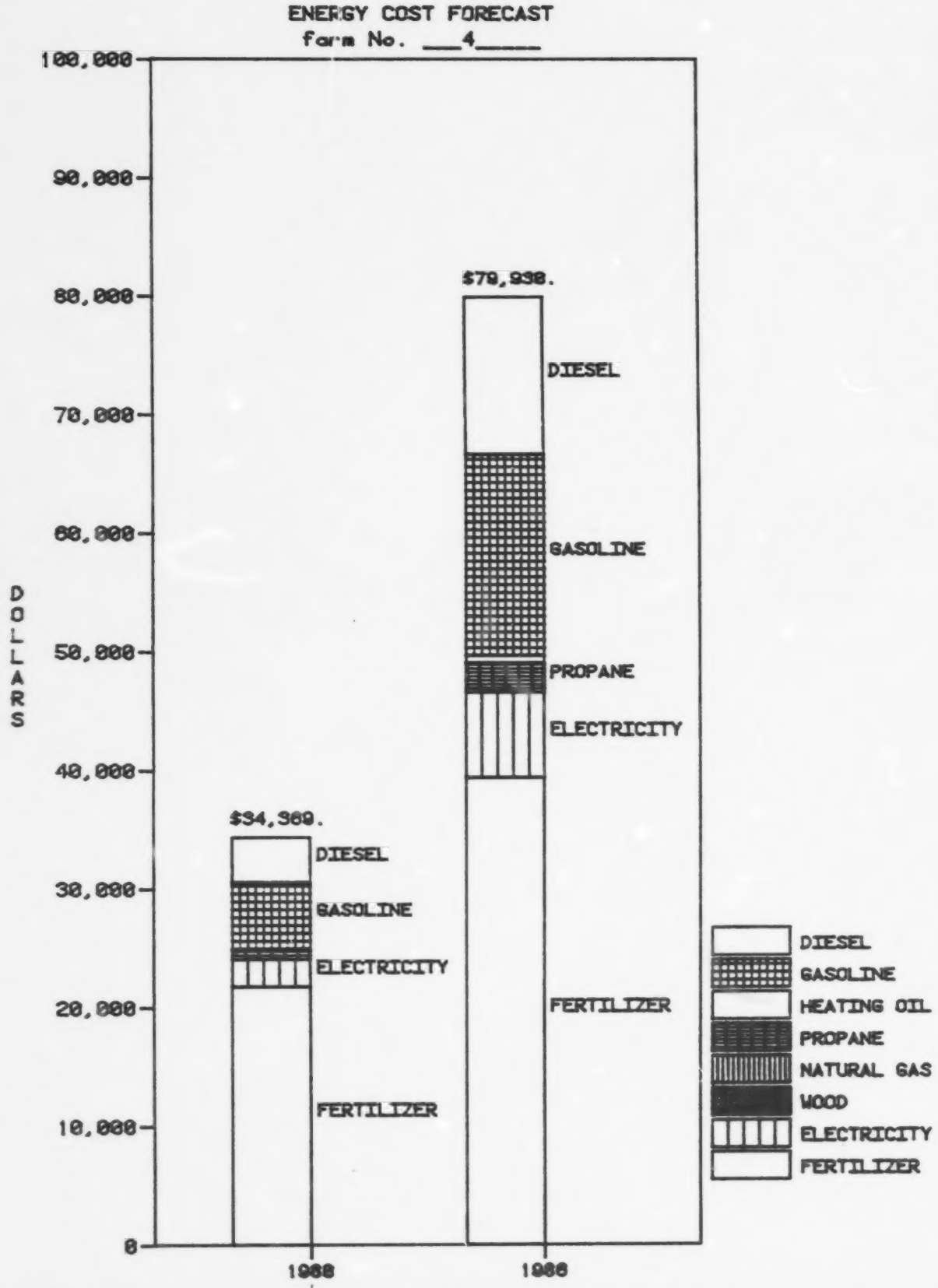
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
Farm No. ___4_____
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
DOLLARS
$79,938.
DIESEL
GASOLINE
PROPANE
ELECTRICITY
FERTILIZER
$34,369.
DIESEL
GASOLINE
ELECTRICITY
FERTILIZER
1988
1988
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 5

FARM INVENTORY:	YEAR 1981	
REGION:	SOUTH EAST	
SOIL ZONE:	BROWN	
SOIL TYPE:	REGINA HEAVY CLAY	
TOPOGRAPHY:	LEVEL	
TOTAL AREA:	1280 ACRES	518 HECTARES
CULTIVATED AREA:	1275 ACRES	515 HECTARES

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1980	

A FarmLab experiment involving snow management is being done. Details of the experiments will be included in the year 2 report.

Crop Production: A three year rotation is practiced on this farm with about 1/3 of the cultivated area summerfallowed in any given year.

The principle crops grown include: spring wheat, utility wheat, durum, and flax.

The tillage and seeding operations for crop grown on stubble include:

- fall harrowing.
- disc seed in spring.
- 2 x harrowing.
- packing.
- post-emergence spray.

For crops grown on summerfallow:

- discer seeding.
- 2 x harrowing.

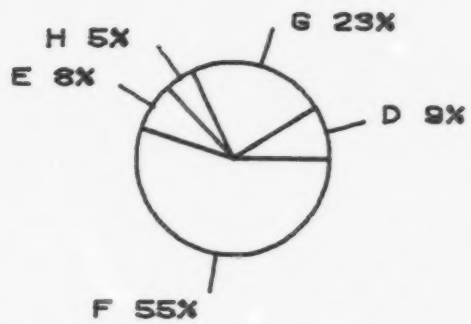
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Review energy efficiency of fertilizer program.
2. Monitor energy impact of FarmLab project (snow management).
3. Review energy use in transportation.
4. Arrange an energy audit of the shop by the Office of Energy Conservation Bus.

FARMER'S ESTIMATED DISTRIBUTION

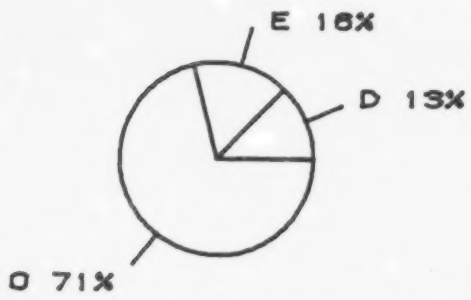
Year 1980 Farm No. 5 Energy Cost $ 10,420 Total Expenses $ 35,820

Energy Cost By Fuel



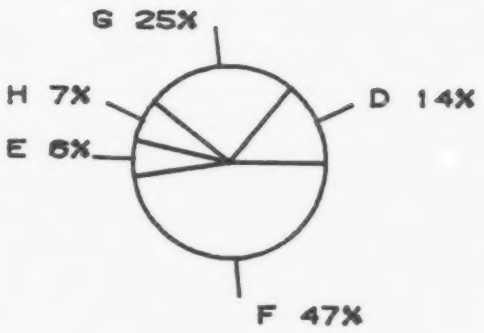
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

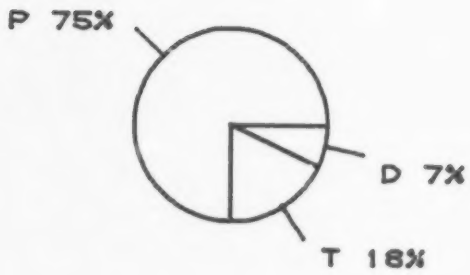


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

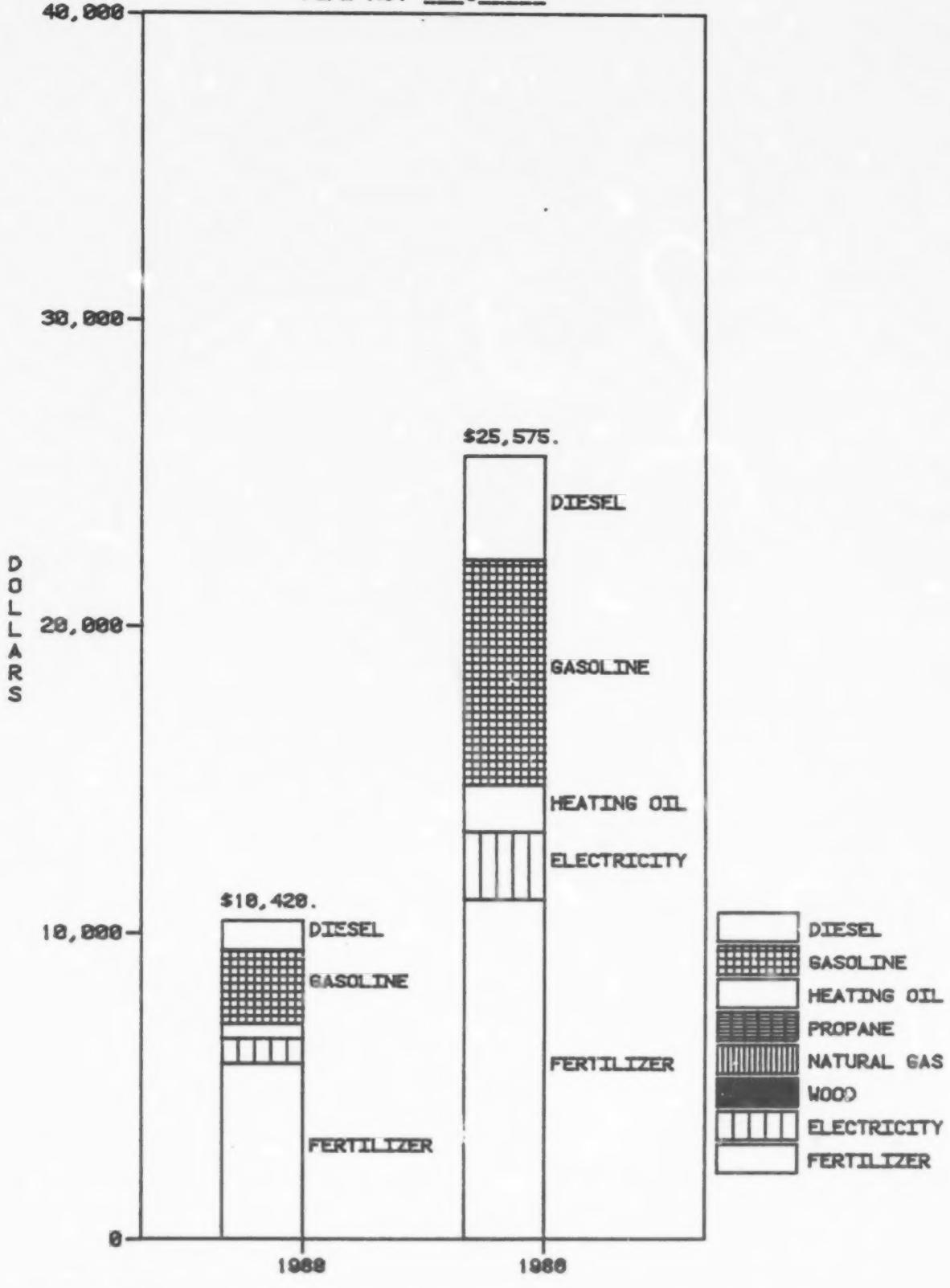


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. ___5_____



FARM 6

FARM INVENTORY:	YEAR 1981	
REGION:	NORTHEAST	
SOIL ZONE:	BLACK	
SOIL TYPE:	TISDALE SILTY CLAY LOAM	
TOPOGRAPHY:	GENTLY ROLLING	
TOTAL AREA:	1920 ACRES	778 HECTARES
CULTIVATED AREA:	1530 ACRES	620 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	BEEF CATTLE	125
BREEDING STOCK:	COWS	100

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1926	864 SF 80 m^2
	FARM HOME	1942	728 SF 68 m^2

Crop Production: These farmers are adopting a more continuous cropping system each year with approximately 1/6 of the cropped land area under summerfallow in 1981.

The principal crops grown include spring wheat, rape, flax, barley and oats. Red clover and alfalfa are grown as hay crops.

Snow management is being experimented with (FarmLab).

The tillage and seeding operations for crops grown on stubble include:

- fall deep tillage cultivation.
- fall broadcast urea and Avadex.
- fall deep tillage cultivation.

- spring deep tillage cultivation.
- rod harrow pack.
- seeding.
- post-emergence spraying.

For crops grown on summerfallow:

- fall applied Treflan with sprayer mounted on a deep tillage cultivator.
- spring deep tillage cultivation.
- rod harrow pack.
- seeding.
- post-emergence spraying.

Summerfallow Operations:

- 6 x deep tillage cultivation (this includes chemical applications.

Fertilizer is applied according to soil test recommendations.

The use of a grain dryer is necessary in most years.

Livestock Production:

These farmers maintain a cow-calf operation with a breeding herd of 100 cows.

The housing system consists of corrals and open sheds; three barn structures are used at calving time. Most of the cattle feed is produced on the farm. A mix mill is used to process the feed and a front-end loader is used for feeding.

The manure pack is loaded on trucks and dumped in piles on the fields each year. The piles are immediately worked into the soil. The total area that has manure applied each year is approximately 10 acres (4 ha).

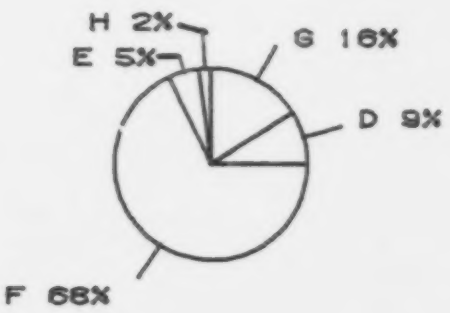
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Investigate retrofit of farm homes.
2. Monitor energy impact of FarmLab Project (snow management).
3. Install monitors to investigate fuel efficiency of various tractors.
4. Analyze efficiency of transportation.
5. Investigate efficiency of grain drying program.
6. Analyze the effect of a legume cropping program.
7. Review the use of manure in the fertilizer program.
8. Arrange an energy audit of the shop by the Office of Energy Conservation Energy Bus.

FARMER'S ESTIMATED DISTRIBUTION

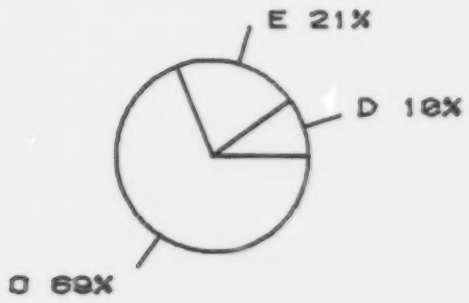
Year 1980 Farm No. 6 Energy Cost $ 27,706 Total Expenses $ 91,018.

Energy Cost By Fuel



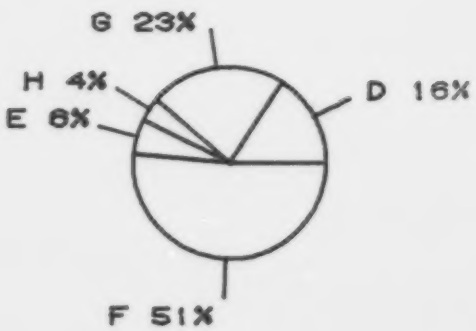
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses



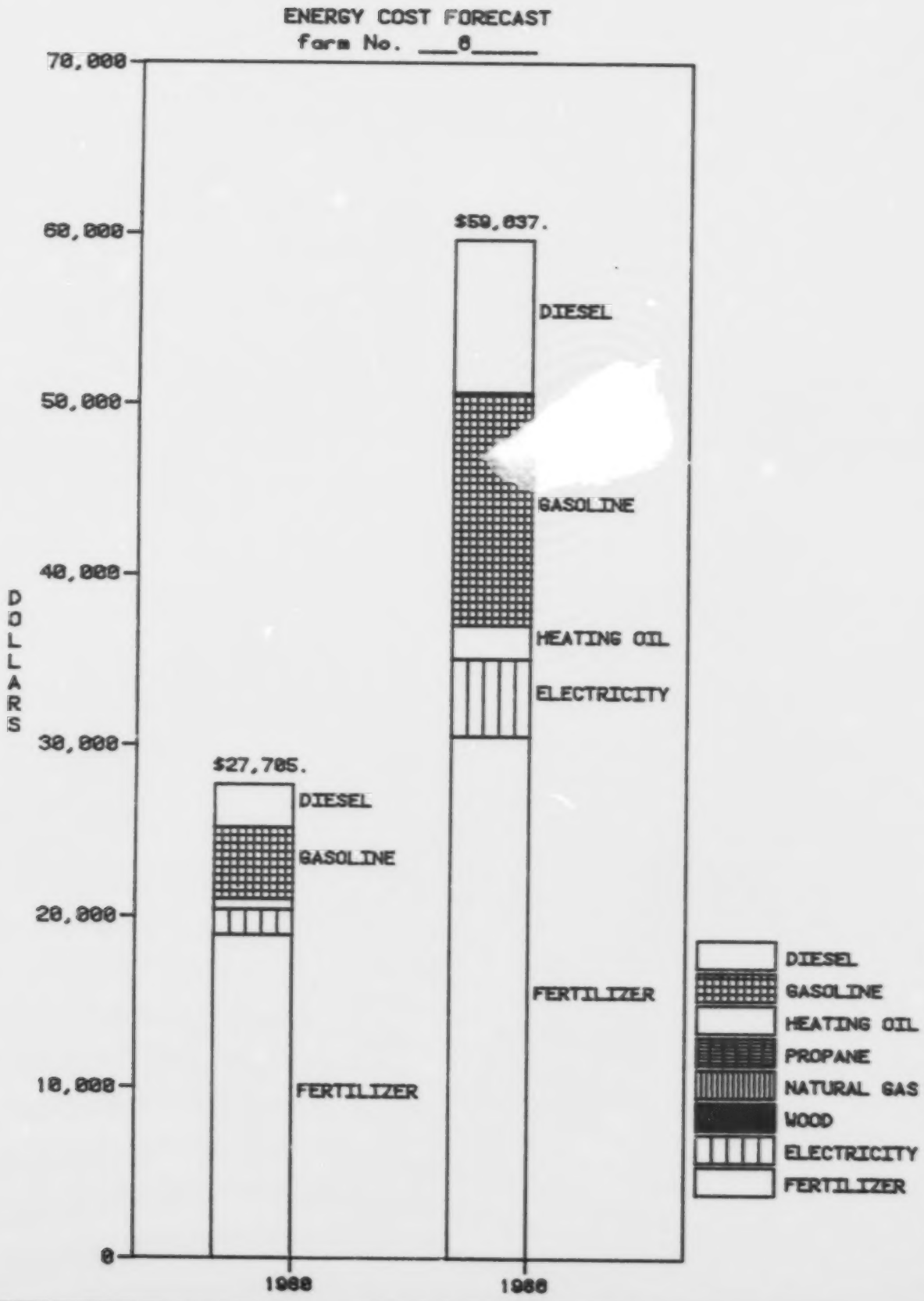
D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic



Energy Content By Fuel

Energy Cost By Sector


ENERGY COST FORECAST
farm No. ___8_____
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
DOLLARS
$59,037.
DIESEL
GASOLINE
HEATING OIL
ELECTRICITY
FERTILIZER
$27,705.
DIESEL
GASOLINE
FERTILIZER
1988
1988
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 7

FARM INVENTORY:	YEAR 1981		
REGION:	EAST CENTRAL		
SOIL ZONE:	BLACK		
SOIL TYPE:	NAICAM LOAM		
TOPOGRAPHY:	GENTLY ROLLING		
TOTAL AREA:	1600 ACRES	648 HECTARES	
CULTIVATED AREA:	1580 ACRES	639 HECTARES	
	ANIMAL	NUMBER	
TOTAL LIVESTOCK:	HOGS	550	
	ANIMAL	NUMBER	
BREEDING STOCK:	SOWS	30	
	TYPE	YEAR BUILT	HEATED AREA
HEATED BARNS AND SHOPS:	BARN	1981	5184 SF 482 m^2
	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1937	1152 SF 107 m^2
	FARM HOME	1962	1200 SF 111 m^2

Crop Production: A two-year cropping rotation is implemented over most of this farm. In 1981, 100 acres (40 ha) was planted on stubble. During the past two years green manuring with sweet clover has been experimented with.

The major crops produced include wheat, barley and rape.

The tillage and seeding operations for crops on stubble include:

- 2 x deep tillage cultivation.
- seed with press drills.

- harrow.
- post-emergence spraying.

For crops grown on summerfallow:

- deep tillage cultivation.
- seeding with press drills.
- harrow.
- post-emergence spraying.

Summerfallow Operations:

- 2 x deep tillage cultivation.
- 2 x rod weed.

Fertilizer is applied according to soil test results.

Crop drying is necessary in some years.

Livestock Production:

A 30 sow farrow-to-finish hog operation is currently under expansion on this farm.

The housing system consists of an old hip roof barn with a new addition presently being constructed.

Liquid manure is stored in an underground pit for approximately three months. In winter the manure is spread on the snow. In summer the manure is worked directly into the soil after application.

Barley, which is grown on the farm is used for feed. Pig starter, sow ration and protein supplement are purchased off the farm and hauled 35 miles (56 km) round trip.

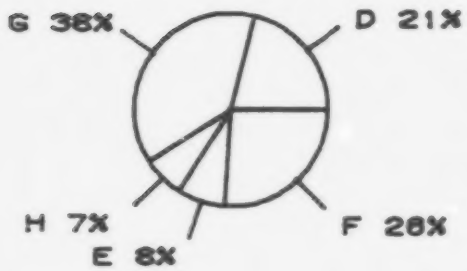
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Investigate barn design and the possible use of heat exchangers in cooperation with Regional Farmstead Engineer.
2. Analyze transportation uses.
3. Analyze fertilizer program and investigate green manure.
4. Investigate economics of greater manure storage capacity.
   - analyze manure re: fertilizer program.
5. Investigate feasibility of methane digester.
6. Analyze energy use in farm homes.
7. Arrange an energy audit of the barn by the Office of Energy Conservation energy bus.

FARMER'S ESTIMATED DISTRIBUTION

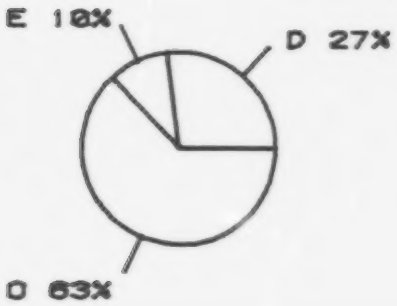
Year 1980 Farm No. 7 Energy Cost $ 15,865. Total Expenses $ 42,362.

Energy Cost By Fuel



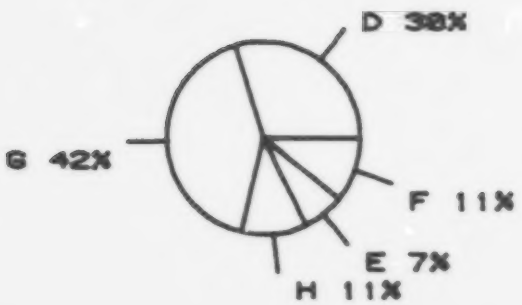
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

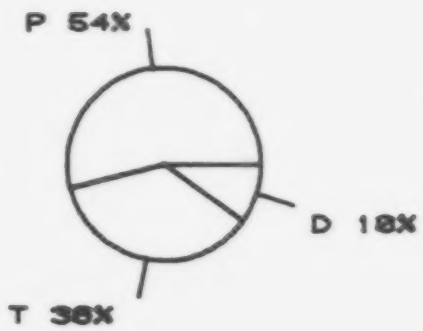


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

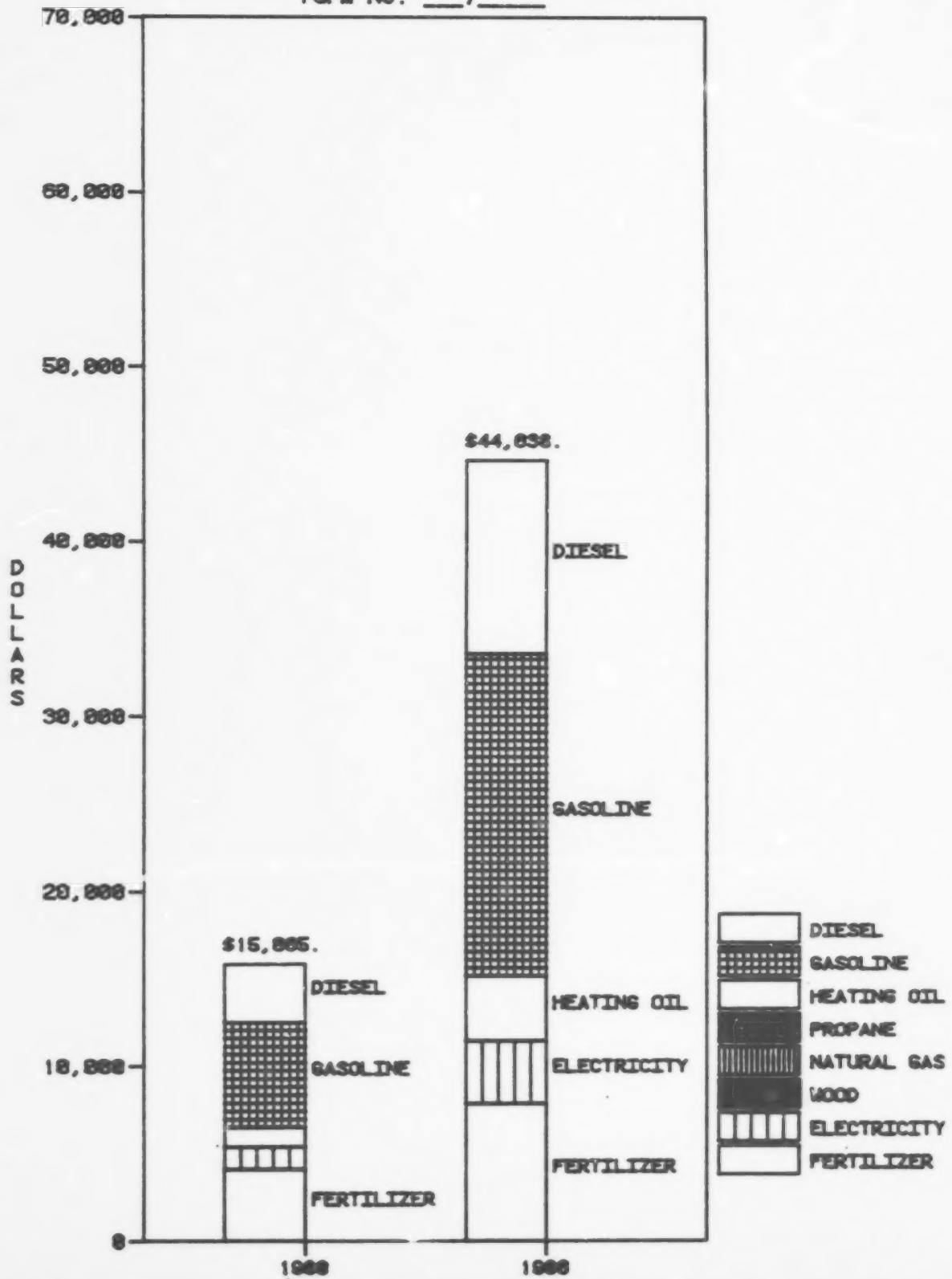


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
form No. ___7_____



FARM 8

FARM INVENTORY:	YEAR 1981	
REGION:	NORTHWEST	
SOIL ZONE:	BLACK	
SOIL TYPE:	BLAINE LAKE LOAM	
TOPOGRAPHY:	GENTLY ROLLING	
TOTAL AREA:	4320 ACRES	1750 HECTARES
CULTIVATED AREA:	4200 ACRES	1701 HECTARES

	TYPE	YEAR BUILT	HEATED AREA
HEATED BARNS AND SHOPS:	SHOP	1979	750 SF 70 m^2

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOUSE	1920	750 SF 70 m^2

Crop Production: On this farm a four year crop rotation is generally practiced.

The principal crops grown are barley and canola.

The tillage and seeding operations for crops grown on stubble include:

- discer.
- deep tillage cultivation.
- anhydrous incorporation.
- harrow and pack.
- 2 x deep tillage cultivation.

- harrow and pack.
- seeding with press drills.
- post-emergence spraying.

For crops grown on summerfallow:

- 2 x light duty cultivation.
- harrow pack.
- seed with press drill.
- post-emergence spraying.

Summerfallow Operations:

- 6 x light duty cultivation.

Fertilizer applied according to soil test recommendation.

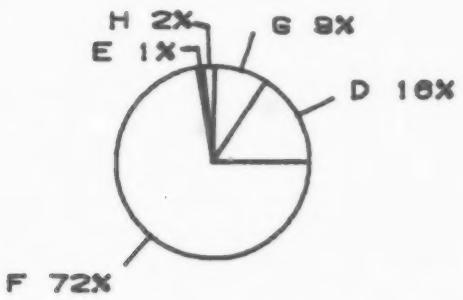
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Arrange an energy audit of the shop by the Office of Energy Conservation Energy Bus.
2. Review energy efficiency in fertilizer program.
3. Analyze efficiency of transportation.
4. Analyze grain drying system.
5. Analyze effectiveness of propane conversion.
6. Assist in monitoring of energy efficient home.
7. Analyze effect of snow-trapping and legume rotation.

FARMER'S ESTIMATED DISTRIBUTION

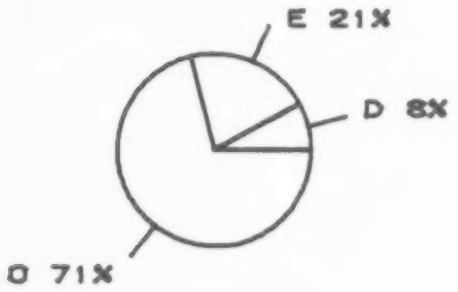
Year 1980 Farm No. 8 Energy Cost $ 105,041. Total Expenses $ 367,000.

Energy Cost By Fuel



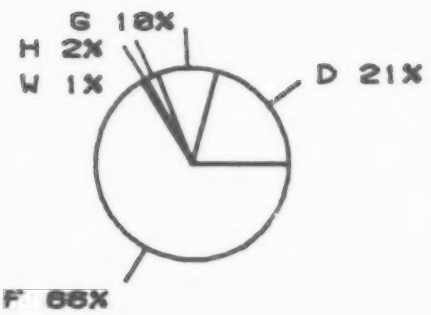
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

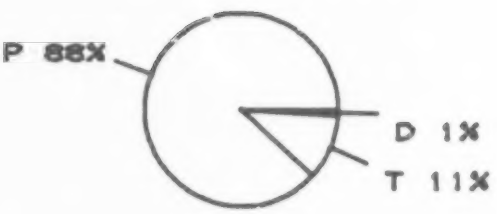


D = Direct Energy
E = Embodied Energy
O = Other

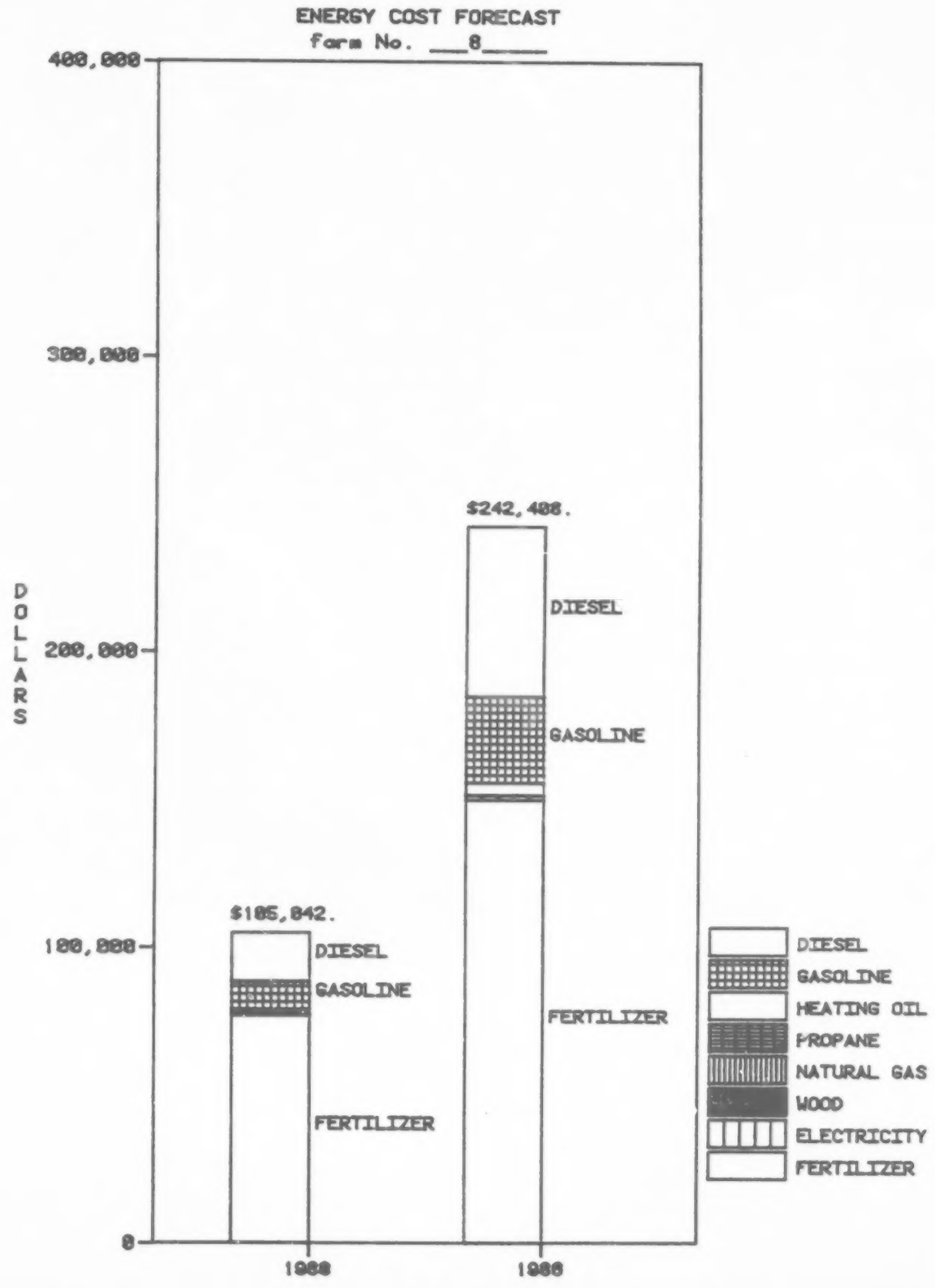
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
Farm No. ___8_____
400,000
300,000
200,000
100,000
0
DOLLARS
$242,488.
DIESEL
GASOLINE
FERTILIZER
$185,842.
DIESEL
GASOLINE
FERTILIZER
1988
1988
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 9

FARM INVENTORY:	YEAR 1981		
REGION:	NORTHWEST		
SOIL ZONE:	DARK BROWN		
SOIL TYPE:	ELSTOW SILTY LOAM		
TOPOGRAPHY:	GENTLY ROLLING		
TOTAL AREA:	800 ACRES	324 HECTARES	
CULTIVATED AREA:	770 ACRES	312 HECTARES	
	ANIMAL	NUMBER	
TOTAL LIVESTOCK:	SHEEP	200	
BREEDING STOCK:	EWES	125	
	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1936	1440 SF 134 M^2

Crop Production: A two-year cropping rotation is practiced on most of the acreage with a small portion (depending on spring moisture conditions) planted to stubble in each year.

Sweet clover is underseeded with some of the crop each year and then is ploughed down as a green manure crop the next spring.

Sheep are grazed on summerfallow fields in summer

The Saskatchewan Research Council and the Crop Development Center, University of Saskatchewan are currently carrying out chaff collection studies on zero till vs conventional tillage on this farm.

The tillage and seeding operations for crops grown on stubble include:

- fall spike.
- rotary harrow in spring.

- discer seed.
- rotary harrow.
- post-emergence spraying.

For crops grown on summerfallow:

- diamond harrow.
- seed with discer.
- rod weed.
- diamond harrow.
- post-emergence spray.

Summerfallow Operations:

- 2 x deep tillage cultivation.
- 2 x rod weed.

No chemical fertilizer is applied to any of the crops on this farm.

Livestock Production:

This farmer maintains a 125 ewe sheep operation.

The sheep graze on the summerfallow fields in the summer and are kept outside in corrals and open sheds in winter. A lambing barn is used in the spring.

Barley, oats and screenings as well as chaff and baled or cut hay is used for feed.

These sheep are custom hauled 80 miles (129 km) to market.

The manure pack is custom loaded and spread on 10 acres (4 ha) each year. After spreading the manure is immediately worked into the soil with a cultivator.

Four cows are also kept for meat and milk production for personal use.

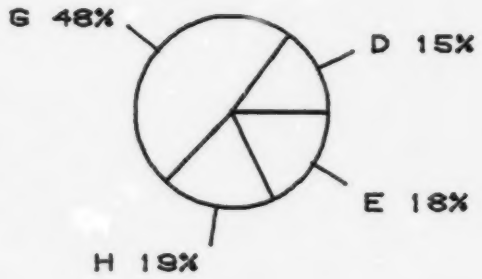
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Arrange an energy audit of the barn by the office of Energy Conservation Energy Bus.
2. Investigate transportation efficiency.
3. Investigate efficiency of chemical fallow (to compare total output of production to total energy input).
4. Assist in energy monitoring of on-going SRC/U of S chaff-collection project.
5. Analyze effectiveness of specific spot herbicide application.
6. Investigate energy use in heating the farm home.
7. Analyze the energy effect of snow management and legumes in rotation.
8. Evaluate grazing as weed control.
9. Consider some method of phosphate fertilizer use.

FARMER'S ESTIMATED DISTRIBUTION

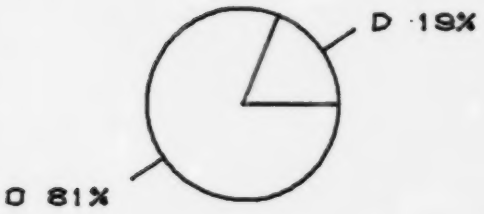
Year 1980 Farm No. 9 Energy Cost $ 3,419. Total Expenses $ 17,957.

Energy Cost By Fuel



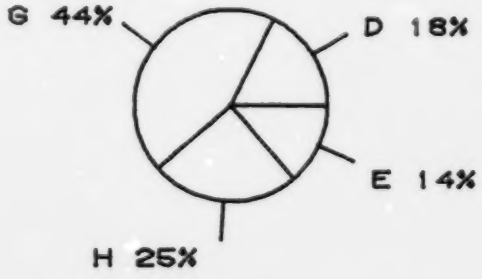
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

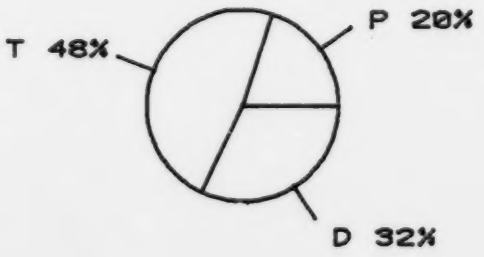


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic



Energy Content By Fuel

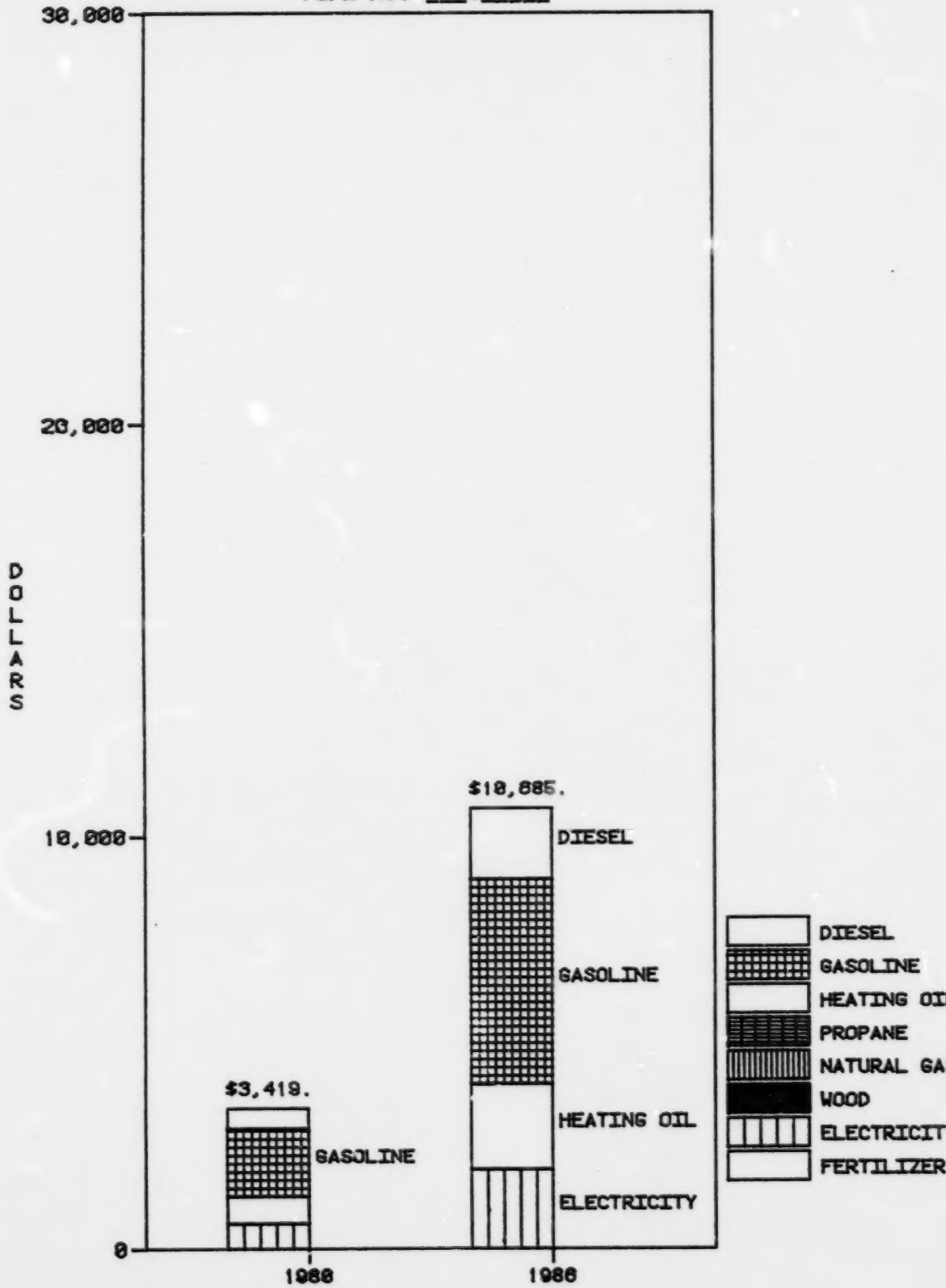


Energy Cost By Sector

A42

ENERGY COST FORECAST

farm No. ___9_____



FARM 10

FARM INVENTORY:	YEAR 1981		
REGION:	SOUTHEAST		
SOIL ZONE:	BROWN		
SOIL TYPE:	TROSSACHS LOAM		
TOPOGRAPHY:	LEVEL		
TOTAL AREA:	480 ACRES	194 HECTARES	
CULTIVATED AREA:	385 ACRES	156 HECTARES	

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	DAIRY COWS	50

	ANIMAL	NUMBER
BREEDING STOCK:	COWS	50

	TYPE	YEAR BUILT	HEATED AREA	
HEATED BARNS AND SHOPS:	DAIRY BARN	0	13460 SF	1250 m^2

	TYPE	YEAR BUILT	HEATED AREA	
HOMES:	FARM HOME*	1976	2580 SF	240 m^2

Crop Production: This farmer uses a continuous cropping system on this farm.

The principle crops grown include: barley and oats. Over 2/3 of the land is planted to alfalfa which is cut for the dairy herd.

The tillage and seeding operations for crops grown on stubble include:

- 2 x deep tillage cultivation.
- seed with press drill.

Chemical fertilizer is not applied to any of the crops.

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* Electrically heated. Meters to be installed in 1982 will measure space heating separate from other electricity use on this dairy farm.

Livestock Production:

A 50- cow dairy herd is maintained on this farm.

The housing system consists of a free stall barn and calving pens. These cows are fed during milking by an automated feeding system.

A parlour system is used for milking.

Manure is hauled and spread on fields immediately after the barns are cleaned. The manure is not worked into the fields immediately after spreading. 150 acres (61 ha) is covered each year.

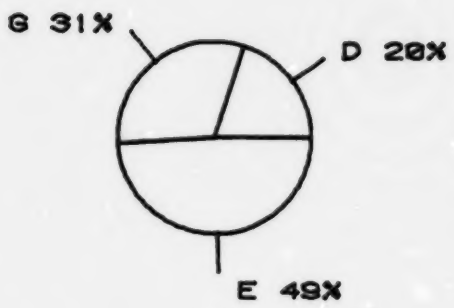
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Review and analyze the manure handling system and use as fertilizer.
2. Investigate the silage feeding program (reduce feed hauling).
3. Analyze the effectiveness of the crop production program.
4. Investigate the feasibility of a heat reclaimer on the bulk tank.
5. Review the ventilation and heating system design in cooperation with Regional Farmstead Engineer.
6. Consider snow management, particularly for alfalfa production.

FARMER'S ESTIMATED DISTRIBUTION

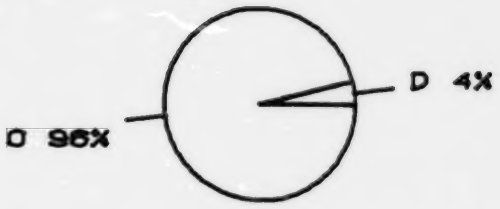
Year 1980 Farm No. 10 Energy Cost $ 6,651. Total Expenses $ 169,213.

Energy Cost By Fuel



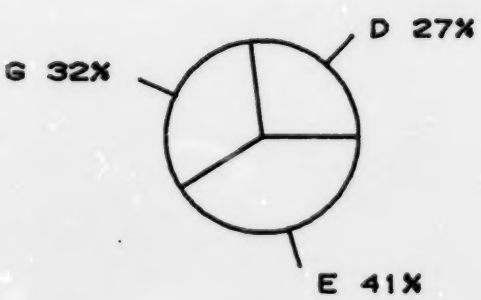
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

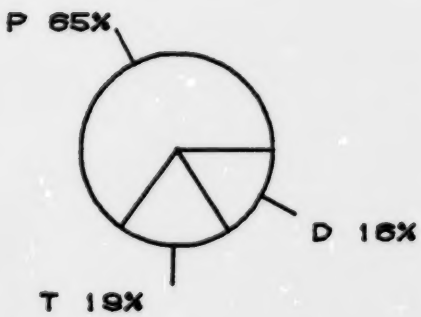


D = Direct Energy
E = Embodied Energy
O = Other

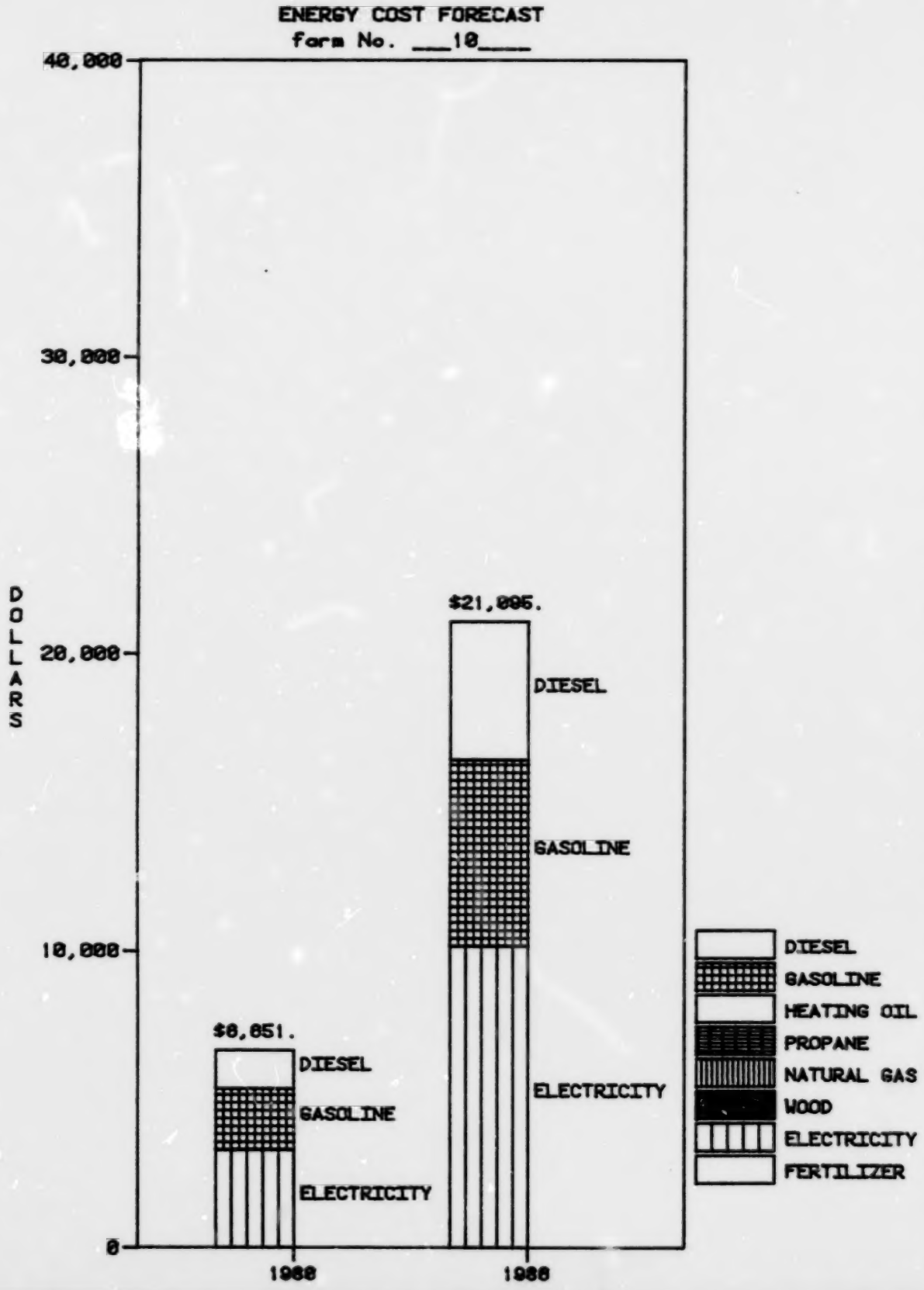
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
form No. ___10____
40,000
30,000
20,000
10,000
0
DOLLARS
$21,095.
DIESEL
GASOLINE
ELECTRICITY
$8,851.
DIESEL
GASOLINE
ELECTRICITY
1988
1988
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 11

FARM INVENTORY:	YEAR 1981	
REGION:	NORTHWEST	
SOIL ZONE:	BLACK	
SOIL TYPE:	OXBOW - WHITESAND LOAM	
TOPOGRAPHY:	ROLLING	
TOTAL AREA:	750 ACRES	304 HECTARES
CULTIVATED AREA:	745 ACRES	302 HECTARES

	TYPE	YEAR BUILT	HEATED AREA	
HOMES:	FARM HOME	1979	1800 SF	167 m^2
	FARM HOME	1920	500 SF	46 m^2
	FARM HOME	1980	1200 SF	111 m^2

Crop Production: This is a three-family farm. A two year-crop rotation is practiced on this farm with wheat being the only cereal crop grown. Brome-alfalfa hay is also produced for market. One family operates a large market garden. The principal garden crops grown include:

- beans, potatoes, squash, cucumbers, carrots, etc.

The tillage and seeding operations for the summerfallow operations include:

- 2 x cultivate.
- seed with a press drill.

Summerfallow operations:

- 2 x cultivate.
- cultivate and harrow.
- 2 x rod weed.

No chemical fertilizers or herbicides are used on this farm for crop production.

The crop is straight combined. These farmers intend to start experimenting with grass strips to trap snow and with winter wheat production.

Market garden produce is hauled 30 miles (48 km) to market.

Livestock Production:

A few cows, chickens and geese are raised for personal use only. The manure is composted and used as a mulch for the gardens.

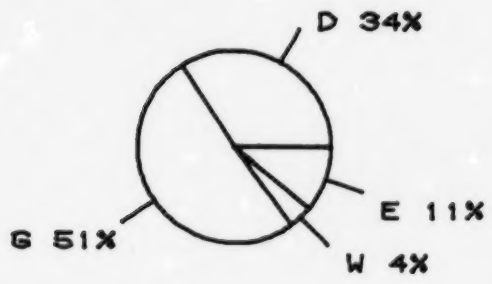
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Monitor the cost effectiveness of using wood as a heat source (already in place).
2. Analyze snow management and winter wheat program.
3. Investigate the use of phosphorus fertilizer as a part of an analysis of the nutrient cycle.
4. Investigate the potential for irrigating the market garden.

FARMER'S ESTIMATED DISTRIBUTION

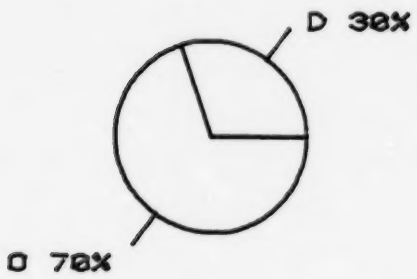
Year 1980 Farm No. 11 Energy Cost $ 1,802. Total Expenses $ 6,000.

Energy Cost By Fuel



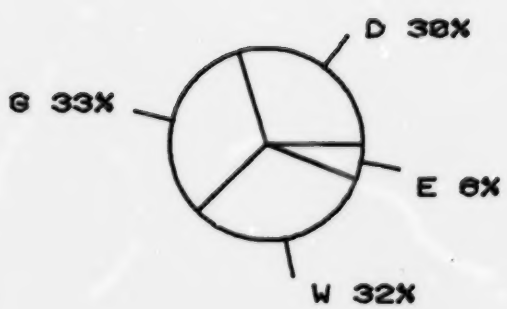
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

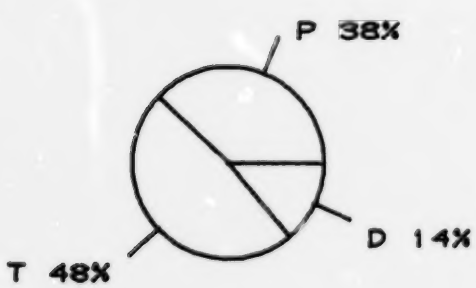


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

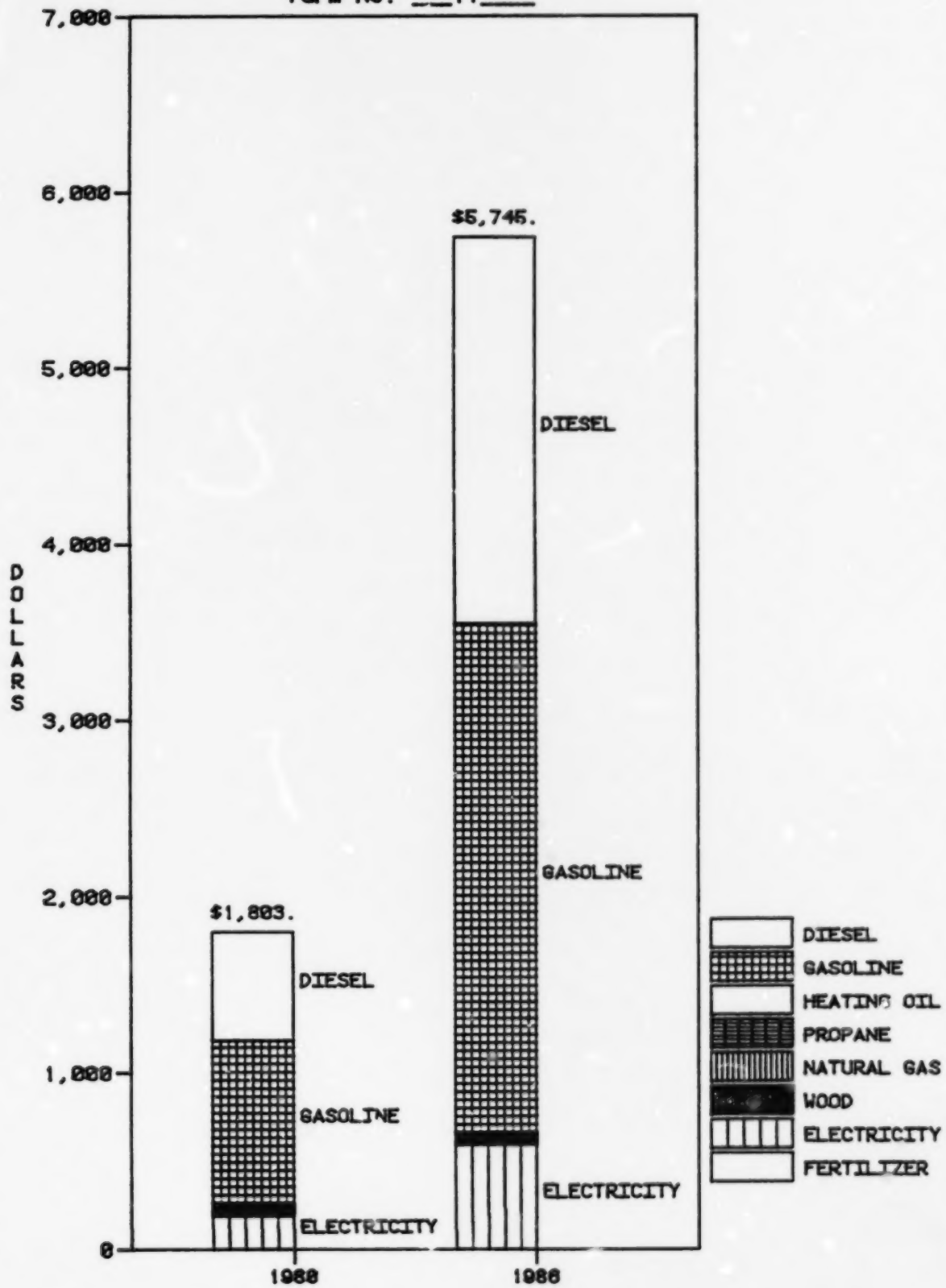


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. __11____



FARM 12

FARM INVENTORY:	YEAR 1981	
REGION:	EAST CENTRAL	
SOIL ZONE:	BLACK	
SOIL TYPE:	NAICAM LOAM	
TOPOGRAPHY:	GENTLY ROLLING	
TOTAL AREA:	720 ACRES	292 HECTARES
CULTIVATED AREA:	470 ACRES	190 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	BEEF CATTLE	45

	ANIMAL	NUMBER
BREEDING STOCK:	COWS	25

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1946	1024 SF 95 m^2

Crop Production: On this farm, an almost continuous cropping rotation is practiced with only a very small portion of the entire land base under cultivation in any given year.

The principal crops grown include:

- spring wheat, barley, durum, alfalfa for seed and sweet clover for seed.

The tillage and seeding operations for crops grown on stubble include:

- fall spike.
- spring harrow.
- light duty cultivation in draws.
- Morris seed rite drill.
- rod weed.
- post-emergence spraying.

Summerfallow Operation:

- spiked after combining in the fall.
- 5 x heavy duty cultivation.

This farmer foliar-feeds his crops with a combination of seaweed and fish sprays.

Snow management in both cereal and forage crops is practised.

Livestock Production:

Rock phosphate is the only fertilizer used on this farm.

This farmer has a cow-calf operation consisting of 30 cows and heifers.

The housing system consists of corrals and open sheds. The cattle self-feed on round bales with electric fence. Feed oats are prepared with a grinder mixer and are pail fed. A tractor with front end loader is used to handle big round bales.

The cattle are custom hauled to market.

The manure pack is composted in summer and then is loaded and spread the following spring. 2.5 tons per acre (5.6 tonnes per ha) is applied to approximately 20 acres/year (8 ha/year).

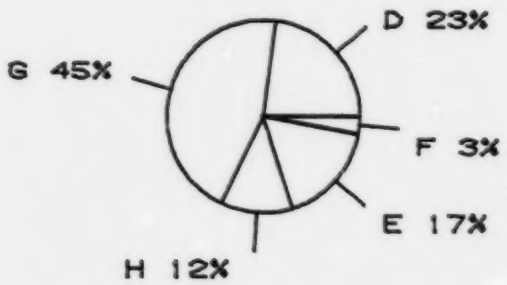
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze the design of a passive solar heating system for the farm shop.
2. Monitor the energy effectiveness of snow management.
3. Monitor the manure management program.
4. Review transportation energy use.
5. Analyze electrical use.
6. Analyze the effectiveness of a house retrofit.

FARMER'S ESTIMATED DISTRIBUTION

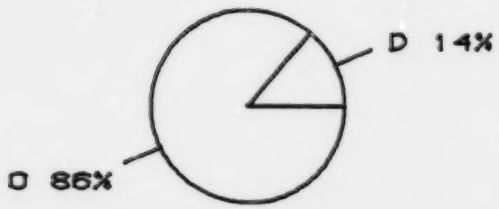
Year 1980 Farm No. 12 Energy Cost $ 4,635. Total Expenses $ 33,104.

Energy Cost By Fuel



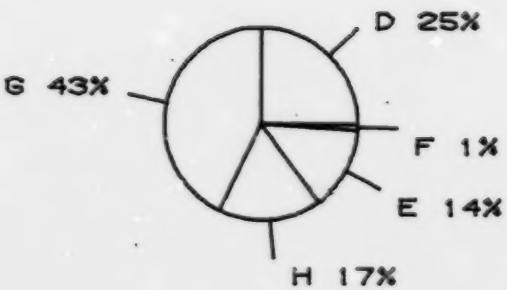
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

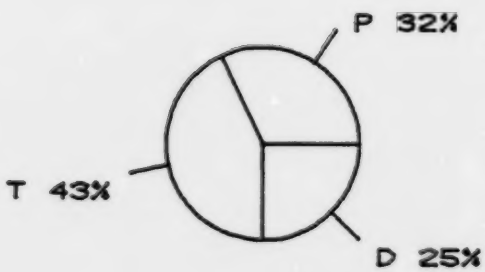


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

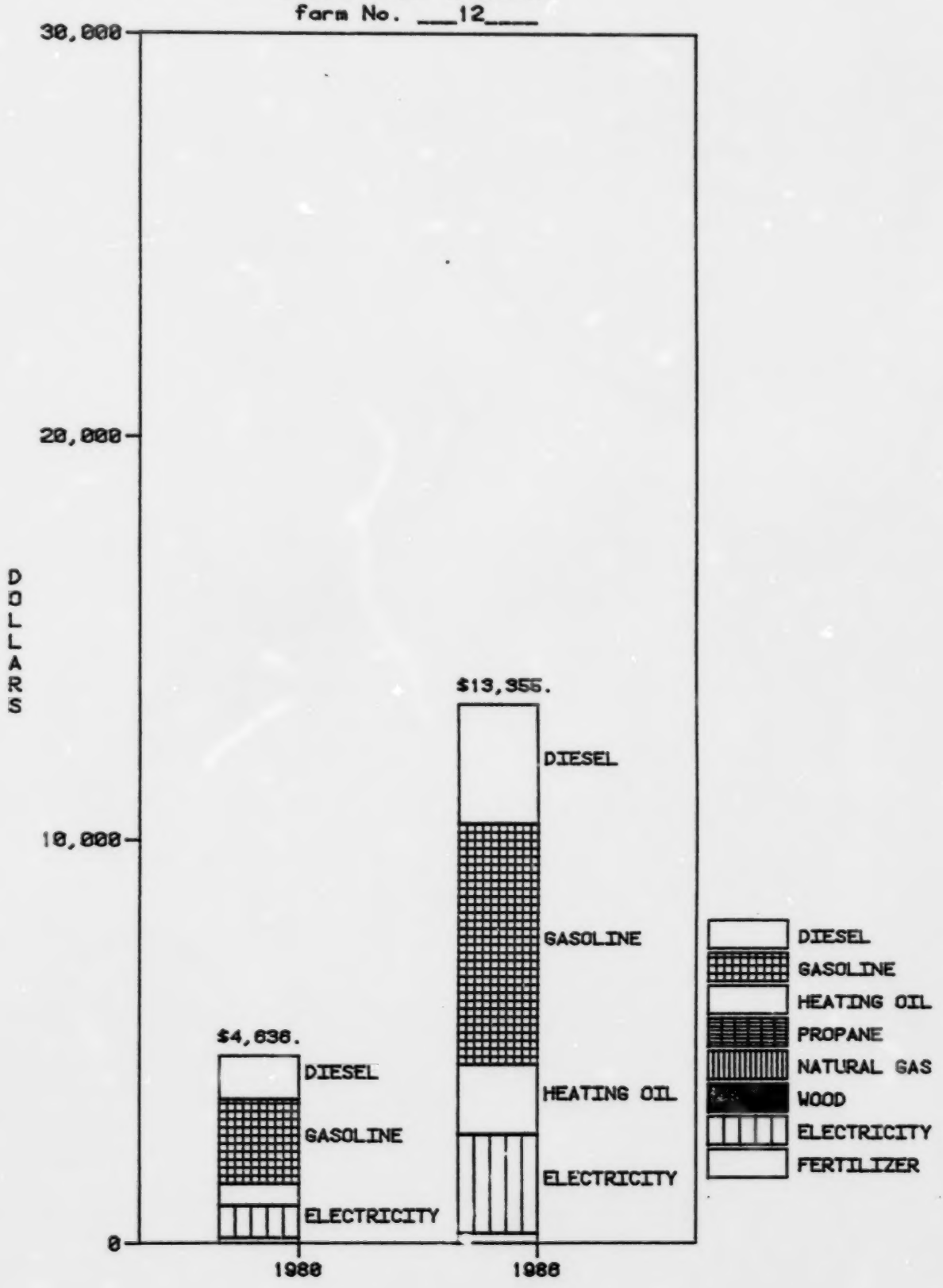


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. ___12____



FARM 13

FARM INVENTORY:	YEAR 1981		
REGION:	EAST CENTRAL		
SOIL ZONE:	DARK BROWN		
SOIL TYPE:	WEYBURN LOAM		
TOPOGRAPHY:	GENTLY ROLLING		
TOTAL AREA:	480 ACRES	194 HECTARES	
CULTIVATED AREA:	284 ACRES	115 HECTARES	

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	HOGS	560
	BEEF CATTLE	40

	ANIMAL	NUMBER
BREEDING STOCK:	SOWS	60
	COWS	20

	TYPE	YEAR BUILT	HEATED AREA
HEATED BARNS AND SHOPS:	FINISH BARN	0	1160 SF 201 m^2
	WEANER BARN	0	0 SF 0 m^2
	FARROWING BARN	0	0 SF 0 m^2

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOUSE	1978	1235 SF 115 M^2

Crop Production: A father and two sons operate this mixed farm jointly. The energy audit has concentrated on the operation of one son who:

- farms three quarters (389 ha).

He is planning to move to a rotation of 25% forage, 25% summerfallow and 50% grain.

- Wheat is grown on summerfallow, and feed grain on stubble.

Field Operations include 2 x cultivatar, 1 x harrow, 1 x spray.

- Seeds with a Double disc drill.

Fertilizer is applied according to soil test recommendations.

Livestock Operation:

- 60 sow farrow - finish on slatted floors.
- good production levels.
- planning to refurbish barn.
- spreads liquid manure on field but is not incorporated (6 weeks storage).

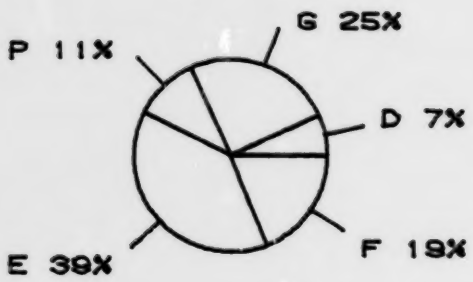
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze the heating and ventilation system of the hog barn in consultation with Regional Farmstead Engineer.
2. Analyze the manure handling system.
3. Evaluate snow management techniques.
4. Arrange an energy audit of the hog barn by the Office of Energy Conservation Energy Bus.

FARMER'S ESTIMATED DISTRIBUTION

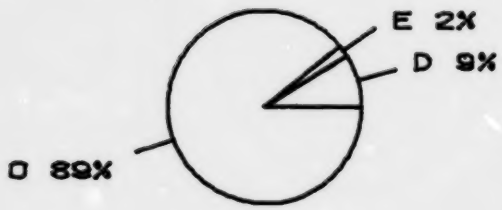
Year 1980 Farm No. 13 Energy Cost $ 11,743. Total Expenses $105,728.

Energy Cost By Fuel



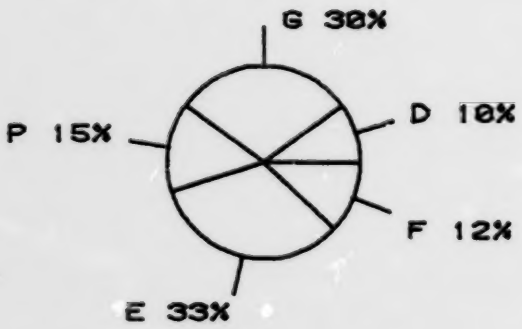
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

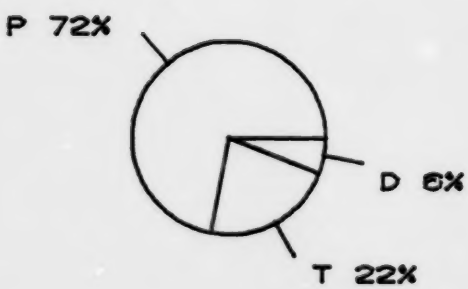


D = Direct Energy
E = Embodied Energy
O = Other

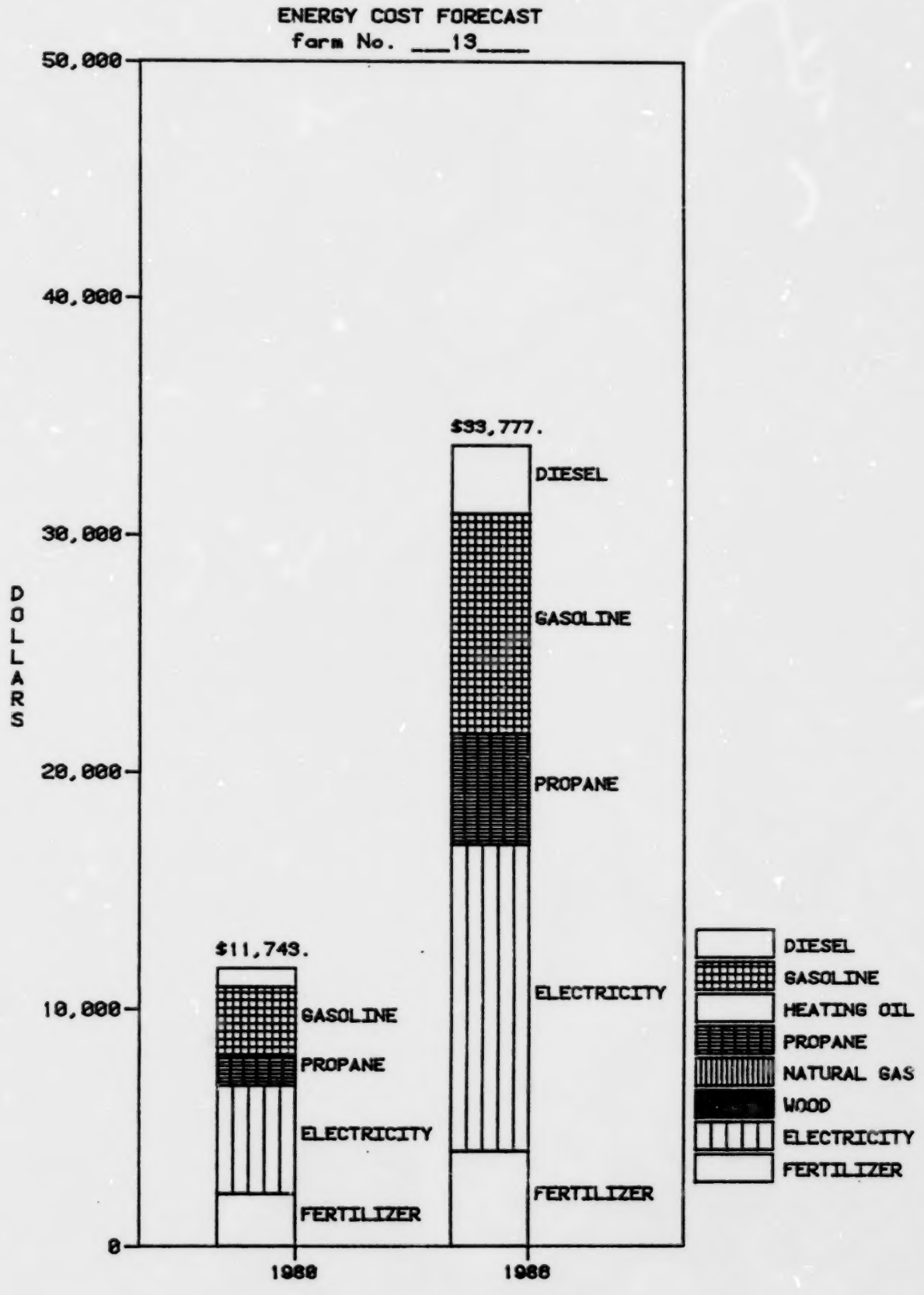
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
farm No. ___13____
50,000
40,000
30,000
20,000
10,000
0
DOLLARS
$33,777.
DIESEL
GASOLINE
PROPANE
ELECTRICITY
FERTILIZER
$11,743.
GASOLINE
PROPANE
ELECTRICITY
FERTILIZER
1988
1988
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 14

FARM INVENTORY:	YEAR 1981	
REGION:	SOUTHWEST	
SOIL ZONE:	BROWN	
SOIL TYPE:	HAVERHILL/SCEPTRE	
TOPOGRAPHY:	ROLLING	
TOTAL AREA:	1760 ACRES	713 HECTARES
CULTIVATED AREA:	1270 ACRES	514 HECTARES

	TYPE	YEAR BUILT	HEATED AREA
HEATED BARNS AND SHOPS:	SHOP	0	2400 SF 223 m^2

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1975	1344 SF 125 m^2

Crop Production: This farm is a straight grain father-son operation, raising mostly wheat on a 2 year rotation.

- fertilize 40 lb. of 11-51-0 plus 40 lb of N broadcast.
- weed control: Avadex, 2,4-D at 8 oz, Round-U on thistles, Sweep on experimental plot, Banvel on chemical fallow x 4.
- summerfallowing: 2,4-D in April, cultivate x 3, Rodweed after harvest.
- seeds with discer-packer.
- FarmLab co-operator (details of the experiment will be given in the year 2 report).

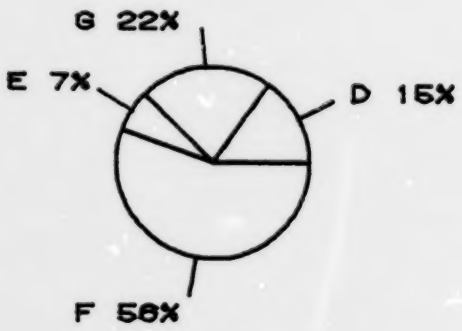
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze the fertilizer progam.
2. Analyze the chemical program.
3. Review transportation efficiency.

FARMER'S ESTIMATED DISTRIBUTION

Year 1980 Farm No. 14 Energy Cost $ 15,262. Total Expenses $ 33,297.

Energy Cost By Fuel



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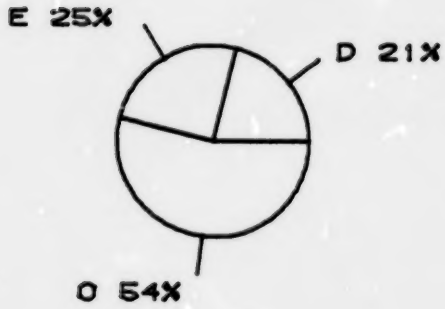
F = Fertilizer

Energy Cost As Percentage Of Total Expenses



D = Direct Energy
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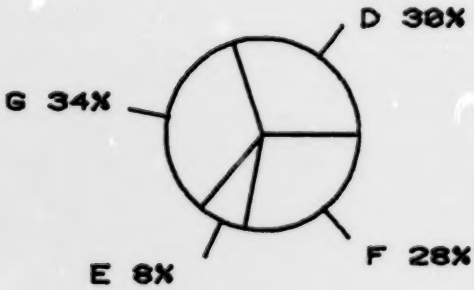
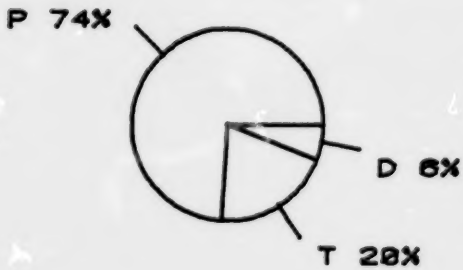
O = Other

P = Production
T = Transportation
D = Domestic

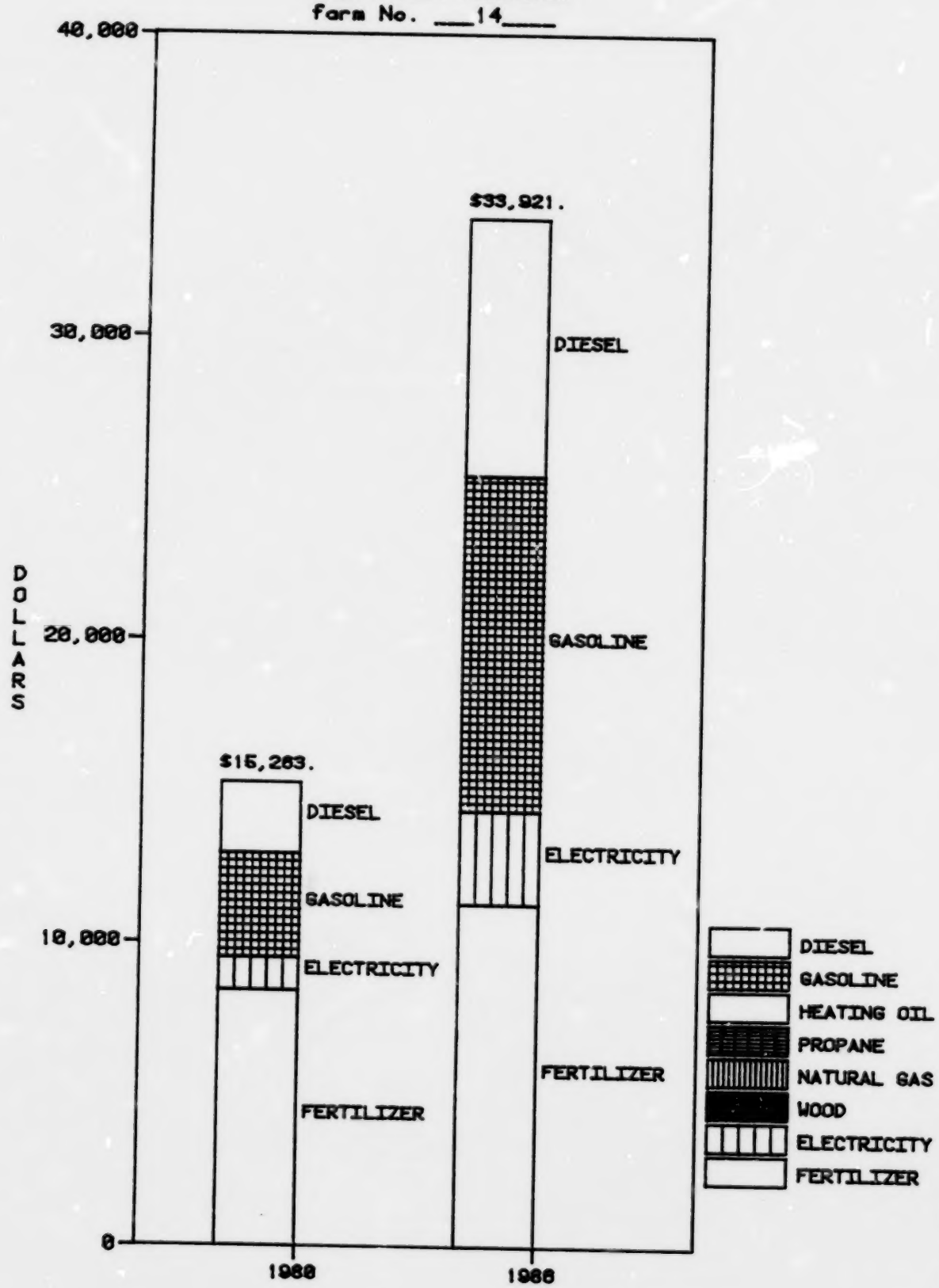


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
form No. ___14____



FARM 15

FARM INVENTORY:	YEAR 1981			
REGION:	SOUTHEAST			
SOIL ZONE:	DARK BROWN			
SOIL TYPE:	WEYBURN ESTEVAN LOAM			
TOPOGRAPHY:	GENTLY ROLLING			
TOTAL AREA:	4640 ACRES	1879 HECTARES		
CULTIVATED AREA:	3000 ACRES	1215 HECTARES		

	TYPE	YEAR BUILT	HEATED AREA	
HEATED BARNS AND SHOPS:	SHOP	0	2400 SF	223 m^2

	TYPE	YEAR BUILT	HEATED AREA	
HOMES:	FARM HOME	1975	1536 SF	143 m^2

Crop Production: This farm is a straight grain operation farmed on a four-year rotation.

- crops grown include - mustard, flax, wheat, durum and sunflowers
- fertilizer - none on summerfallow (dry year)
  - 60 # nitrogen stubble
- summerfallowing: cultivate x 4
  rodweed x 2
- seed with Terra discers, packed twice.
- draining potholes
- 1981 crop reduced due to drought.

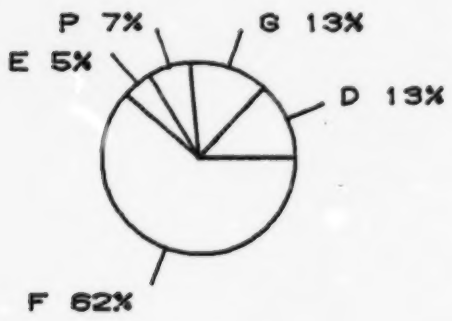
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Investigate electrical use in the home.
2. Analyze the effectiveness of the fertilizer program.
3. Consider alternate fuel-engines when trading vehicles.
4. Arrange an energy audit of farm shop by the Office of Energy Conservation energy bus.
5. Consider the possiblity of testing snow management (4 year rotation in the dark brown soil zone).

FARMER'S ESTIMATED DISTRIBUTION

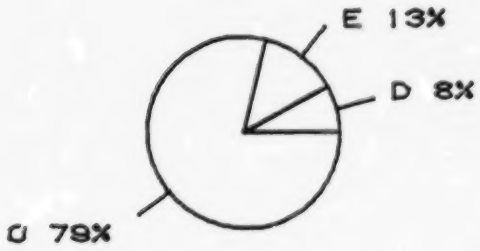
Year 1980 Farm No. 15 Energy Cost $ 40,712. Total Expenses $195,434.

Energy Cost By Fuel



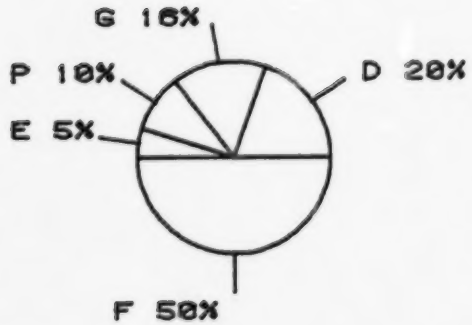
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage
Of Total Expenses

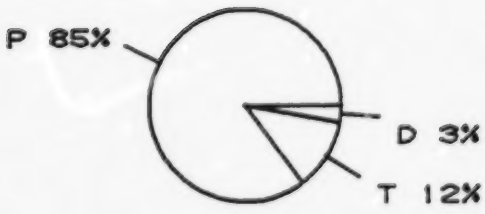


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

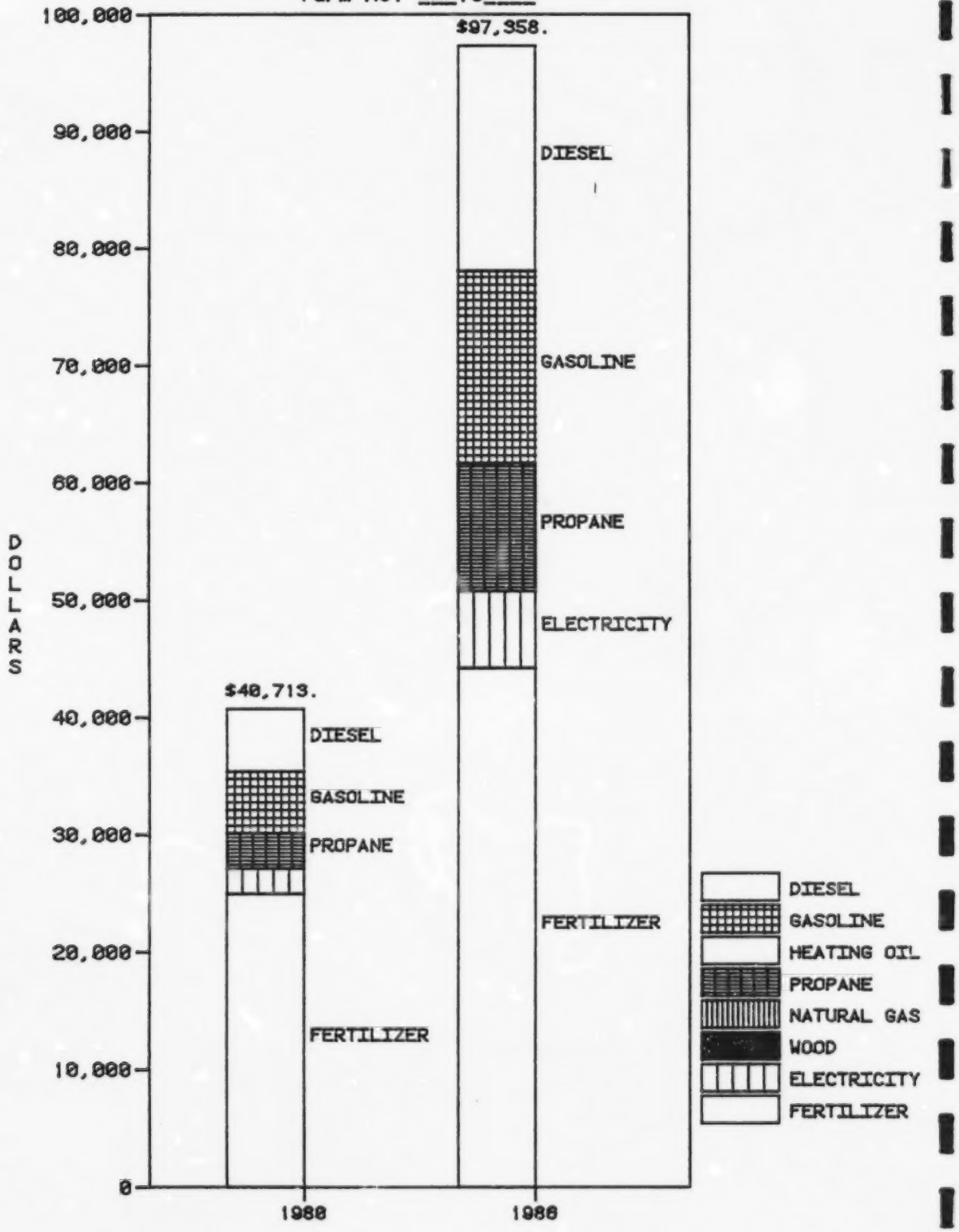


Energy Content
By Fuel



Energy Cost
By Sector

ENERGY COST FORECAST
farm No. ___15____



FARM 16

FARM INVENTORY:	YEAR 1981	
REGION:	WEST CENTRAL	
SOIL ZONE:	BROWN	
SOIL TYPE:	ROBBART CLAY LOAM	
TOPOGRAPHY:	GENTLY ROLLING	
TOTAL AREA:	1440 ACRES	583 HECTARES
CULTIVATED AREA:	1350 ACRES	547 HECTARES

	TYPE	YEAR BUILT	HEATED AREA	
HOMES:	FARM HOME	1916	800 SF	74 m^2

Crop Production: This farm is a straight grain farm raising mostly wheat on a two-year rotation.

- deep banded nitrogen, plus 38 lbs of 11-51-0.
- seeds with hoe drill.
- weed control: 2,4-D + Banvel, 2,4-D, and Round-up.
- summerfallowing - cultivate x 2
  - cultivate + rodweed x 1
  - rodweed x 1
- FarmLab co-operator (details of the experiment will be give in the year 2 report).

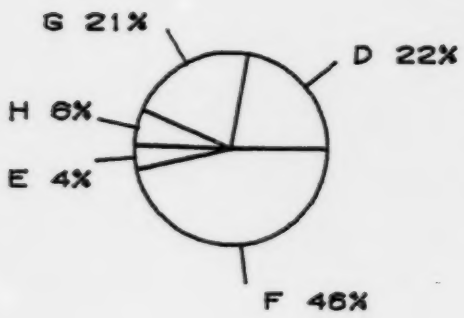
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze the fertilizer program.
2. Review the energy efficiency of cropping practices.

FARMER'S ESTIMATED DISTRIBUTION

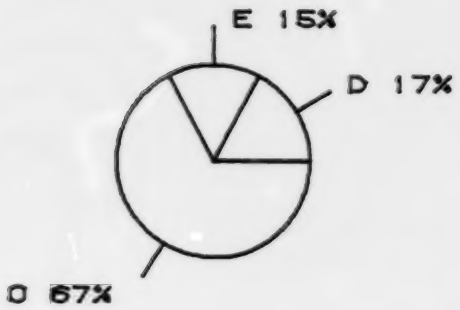
Year 1980 Farm No. 16 Energy Cost $ 10,118 Total Expenses $ 28,164.

Energy Cost By Fuel



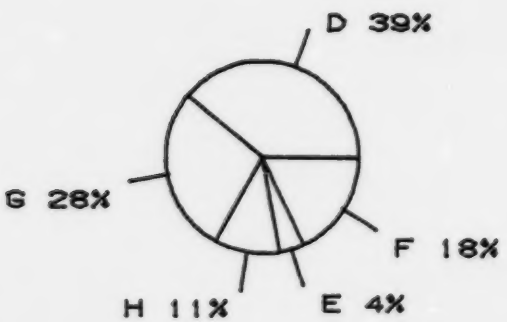
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage
Of Total Expenses

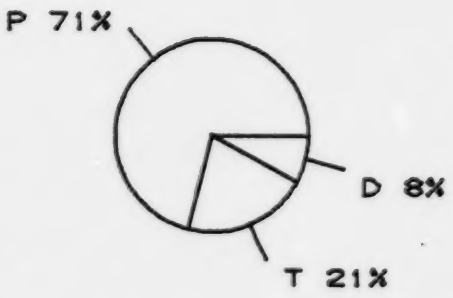


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

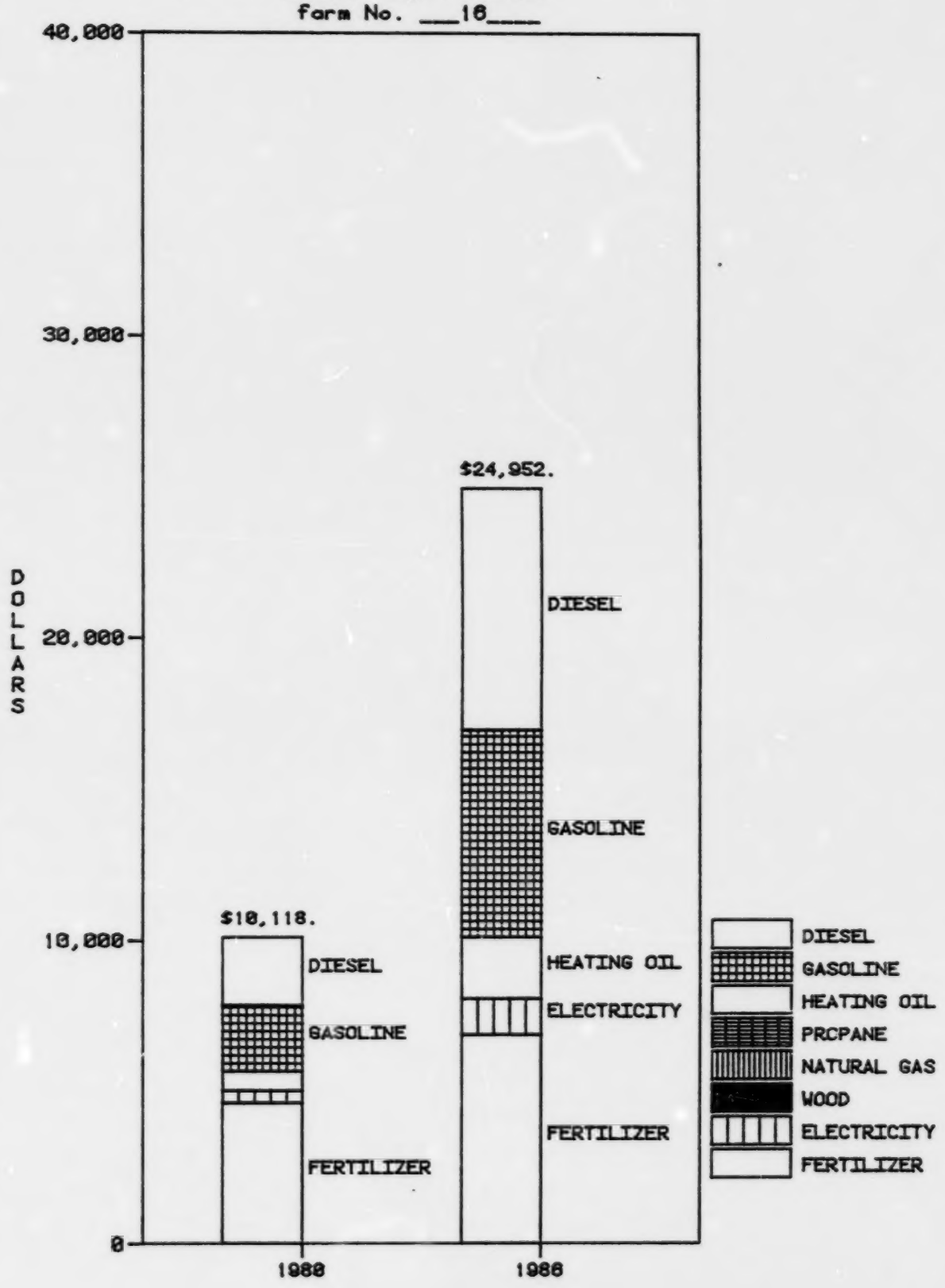


Energy Content
By Fuel



Energy Cost
By Sector

ENERGY COST FORECAST
farm No. ___16____



FARM 17

FARM INVENTORY:	YEAR 1981		
REGION:	SOUTH WEST		
SOIL ZONE:	BROWN		
SOIL TYPE:	CYPRESS/HAVERHILL		
TOPOGRAPHY:	ROLLING		
TOTAL AREA:	1120 ACRES	454 HECTARES	
CULTIVATED AREA:	932 ACRES	377 HECTARES	

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	CATTLE	30

	ANIMAL	NUMBER
BREEDING STOCK:	COWS	21

	TYPE	YEAR BUILT	HEATED AREA	
HOMES:	FARM HOME	1907	1300 SF	121 m^2

Crop production: This mixed farm is a father-son operation. The major crop is wheat grown on a two-year rotation. An innovative farm production package (to be described in the year 2 report) is being placed on the farm for FarmLab.

- fertilizes with 35 lbs of 11-48-0
- seeds with discer
- weed control: amine 80 + Banvel
- summerfallowing: cultivate x 3 + rodweed x 1
- livestock - 21 cows
  - 9 heifers on feed
- manure spread on hill tops
- feed grown on farm and placed close to feeding area

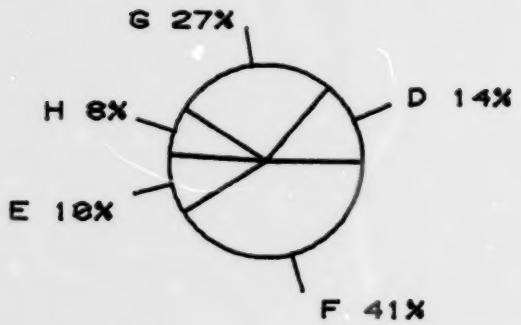
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Monitor innovative farm production package (Farm Lab).
2. Review transportation efficiency.
3. Arrange an energy audit of the farm home by the Saskatchewan Research Council Housing Group.

FARMER'S ESTIMATED DISTRIBUTION

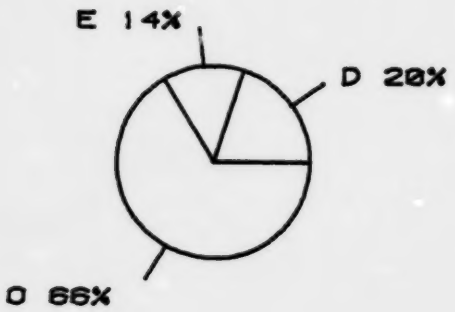
Year 1980 Farm No. 17 Energy Cost $ 6,281. Total Expenses $ 17,188.

Energy Cost By Fuel



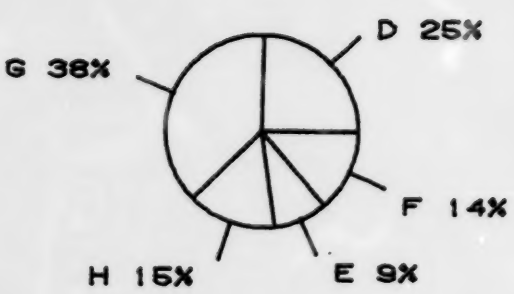
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

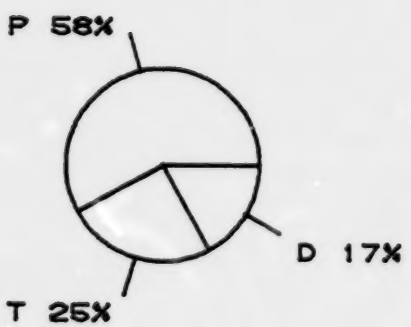


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

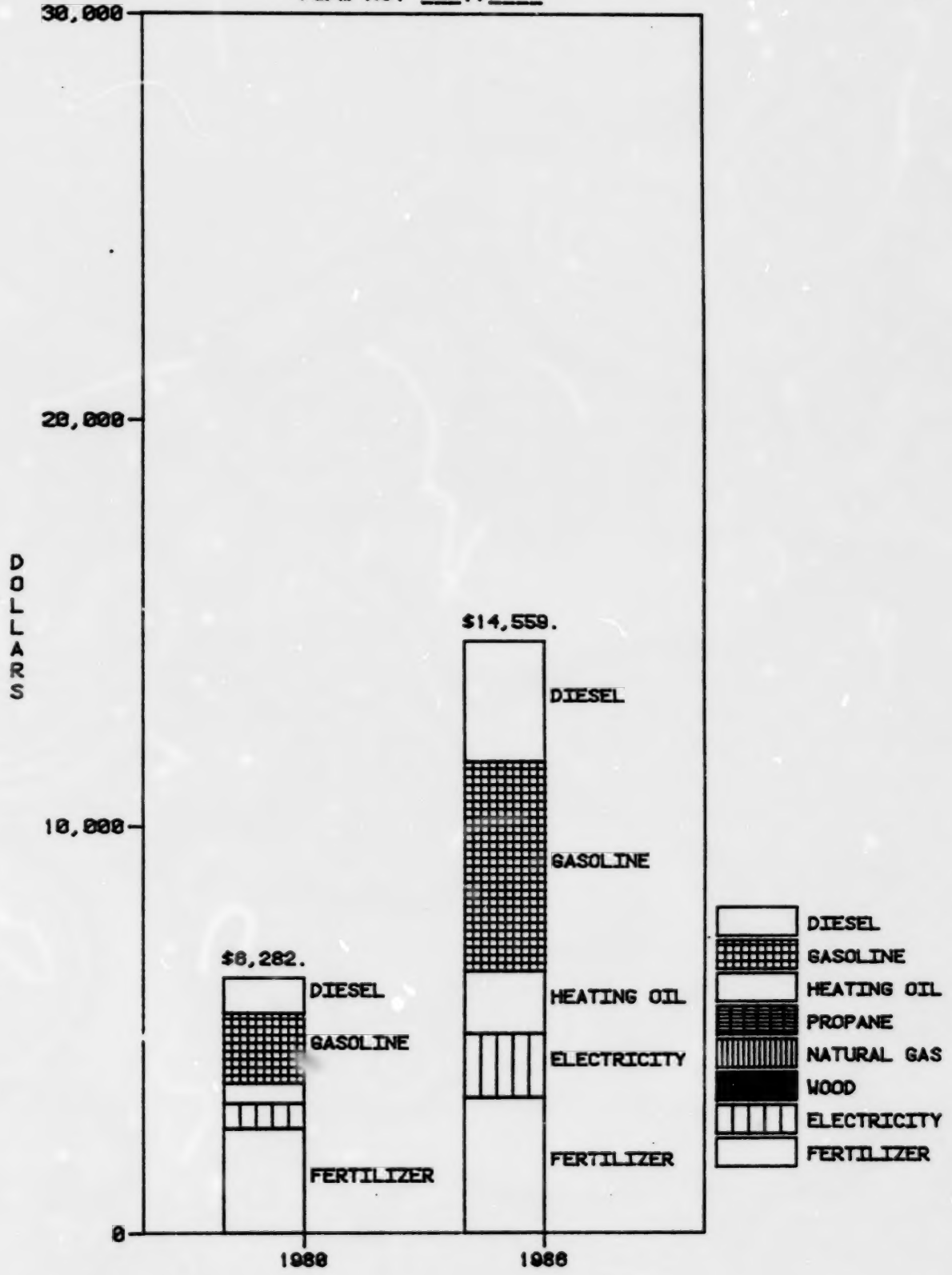


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. ___17____



FARM 18

FARM INVENTORY:	YEAR 1981	
REGION:	WEST CENTRAL	
SOIL ZONE:	BROWN	
SOIL TYPE:	REGINA HAVERHILL	
TOPOGRAPHY:	LEVEL/ROLLING	
TOTAL AREA:	3200 ACRES	1296 HECTARES
CULTIVATED AREA:	2700 ACRES	1094 HECTARES

	TYPE	YEAR BUILT	HEATED AREA
HEATED BARNS AND SHOPS:	SHOP	1977	1200 SF 111 m^2
HOMES:	FARM HOME	1981	1380 SF 128 m^2

Crop production: This farm is a sole proprietorship with sons nearing the age for involvement. The main crops grown are wheat, barley and durum on approximately a two year rotation.

- fertilizes 173 pounds of 46-0-0 and 30 pounds of 11-51-0 on stubble and 40 pounds of 11-51-0 on summerfallow.
- weed control - Buctril M, Avadex
- seeds with discer and rodweeder and harrow
- summerfallowing - cultivate x 2
  - rodweed x 2
- test plot of chemical fallow (Sweep)
- wide variation in soil types from Regina Clay to Haverhill Loam.

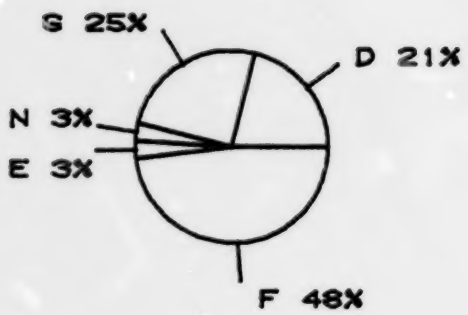
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze the energy efficiency of chemical fallow.
2. Analyze transportation efficiency.
3. Arrange an energy audit of the farm shop by the Office of Energy Conservation energy bus.

FARMER'S ESTIMATED DISTRIBUTION

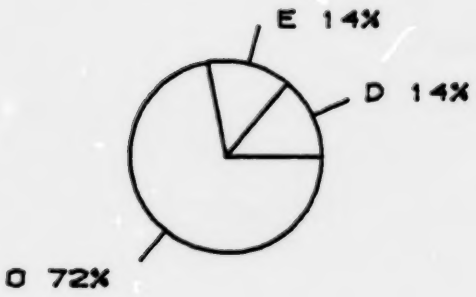
Year 1980 Farm No. 18 Energy Cost $ 20,199. Total Expenses $ 72,500.

Energy Cost By Fuel



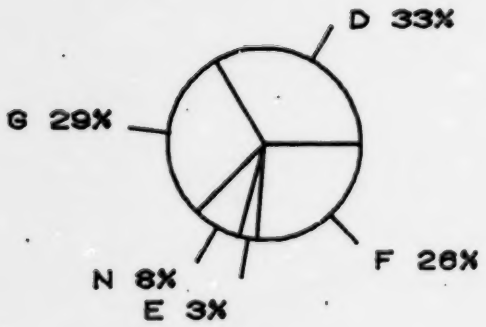
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

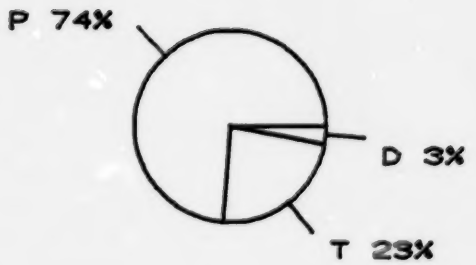


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

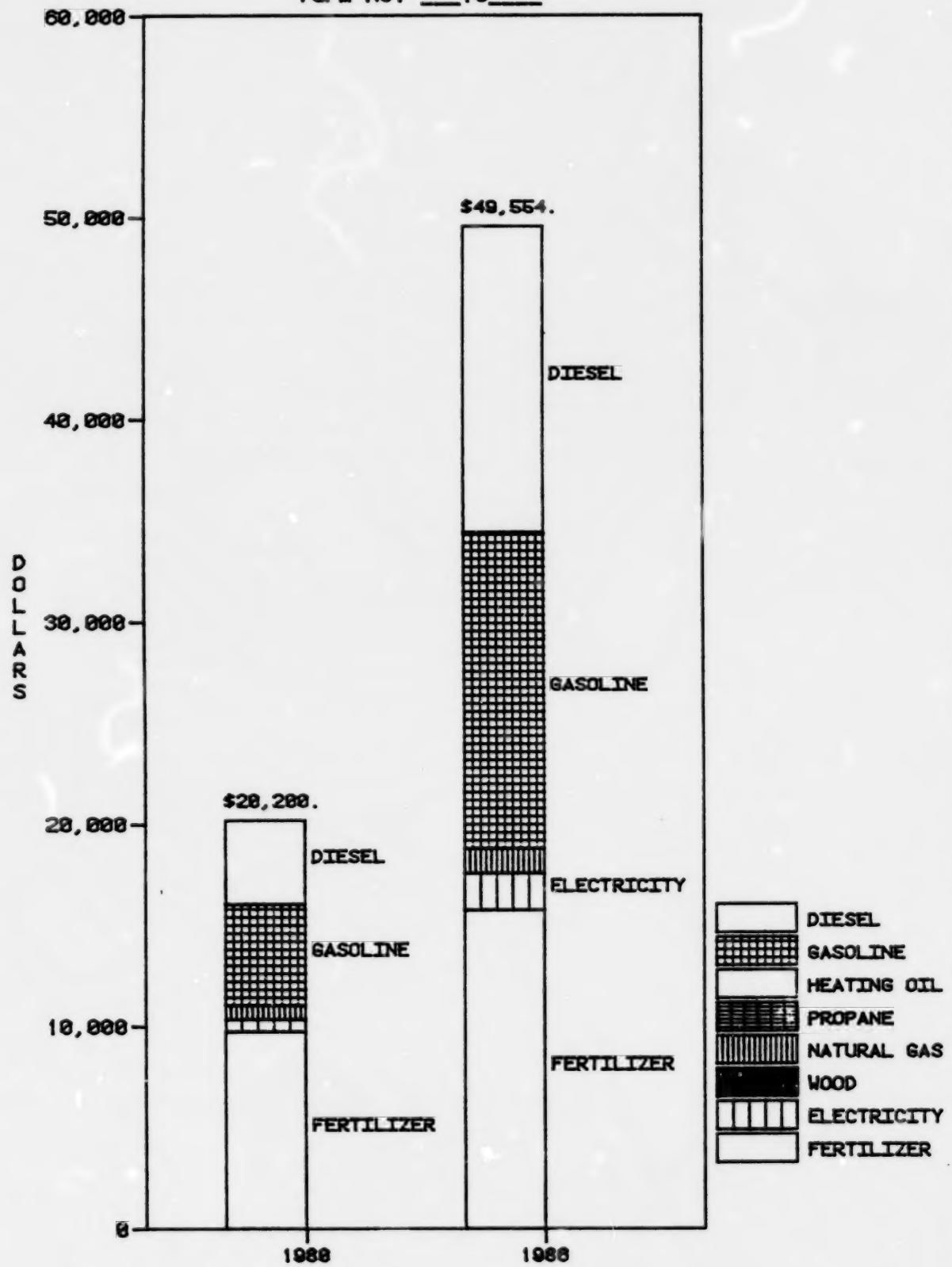


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. ___18____



FARM 19

FARM INVENTORY:	YEAR 1981		
REGION:	SOUTH WEST		
SOIL ZONE:	BROWN		
SOIL TYPE:	HAVERHILL LOAM		
TOPOGRAPHY:	ROLLING		
TOTAL AREA:	1760 ACRES	713 HECTARES	
CULTIVATED AREA:	275 ACRES	111 HECTARES	

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	BEEF CATTLE	200

	ANIMAL	NUMBER
BREEDING STOCK:	BEEF COWS	110

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	MOBILE HOME	1968	624 SF 58 m^2

Crop production: This unit is a ranch. The crops which are seeded are cut as green feed for the cow-calf enterprise. The rotation is oats, rye, sweet clover. The only fertilizer used comes from calves which are fed during the winter. Cows are fed in the field and the location is moved each day to avoid high deposits of manure in any one area.

The livestock operation was a cow-calf operation until 1980 when animals were finished for market.

Feed for the cows is grown on the farm but the calves are fed alfalfa cubes which are bought and delivered to the farm. For the feeder operation, all the feed is purchased and delivered to the farm feed processor. A small truck is the main equipment used to feed the cattle or a small gas tractor may have to be used in the spring.

Major users of gasoline are a partner who travels to the farm and a wife who works off the farm.

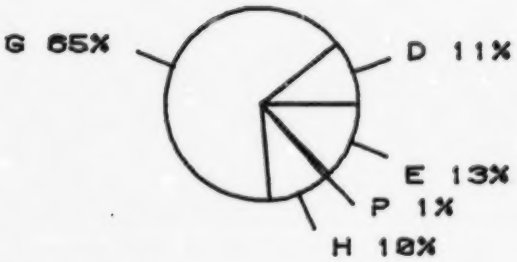
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze the transportation efficiency.
2. Investigate energy effectiveness of the cropping practices.
3. Investigate the use of wind energy.

FARMER'S ESTIMATED DISTRIBUTION

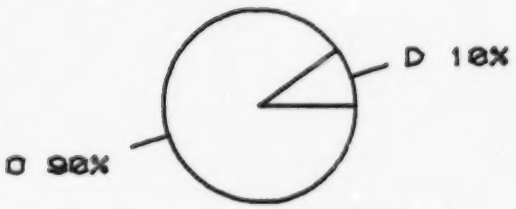
Year 1980 Farm No. 19 Energy Cost $ 4,006. Total Expenses $ 40,772.

Energy Cost By Fuel



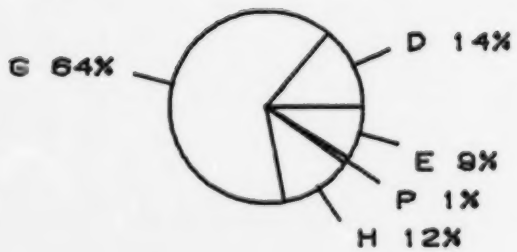
D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

Energy Cost As Percentage Of Total Expenses

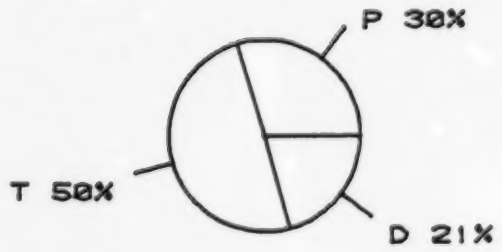


D = Direct Energy
E = Embodied Energy
O = Other

P = Production
T = Transportation
D = Domestic

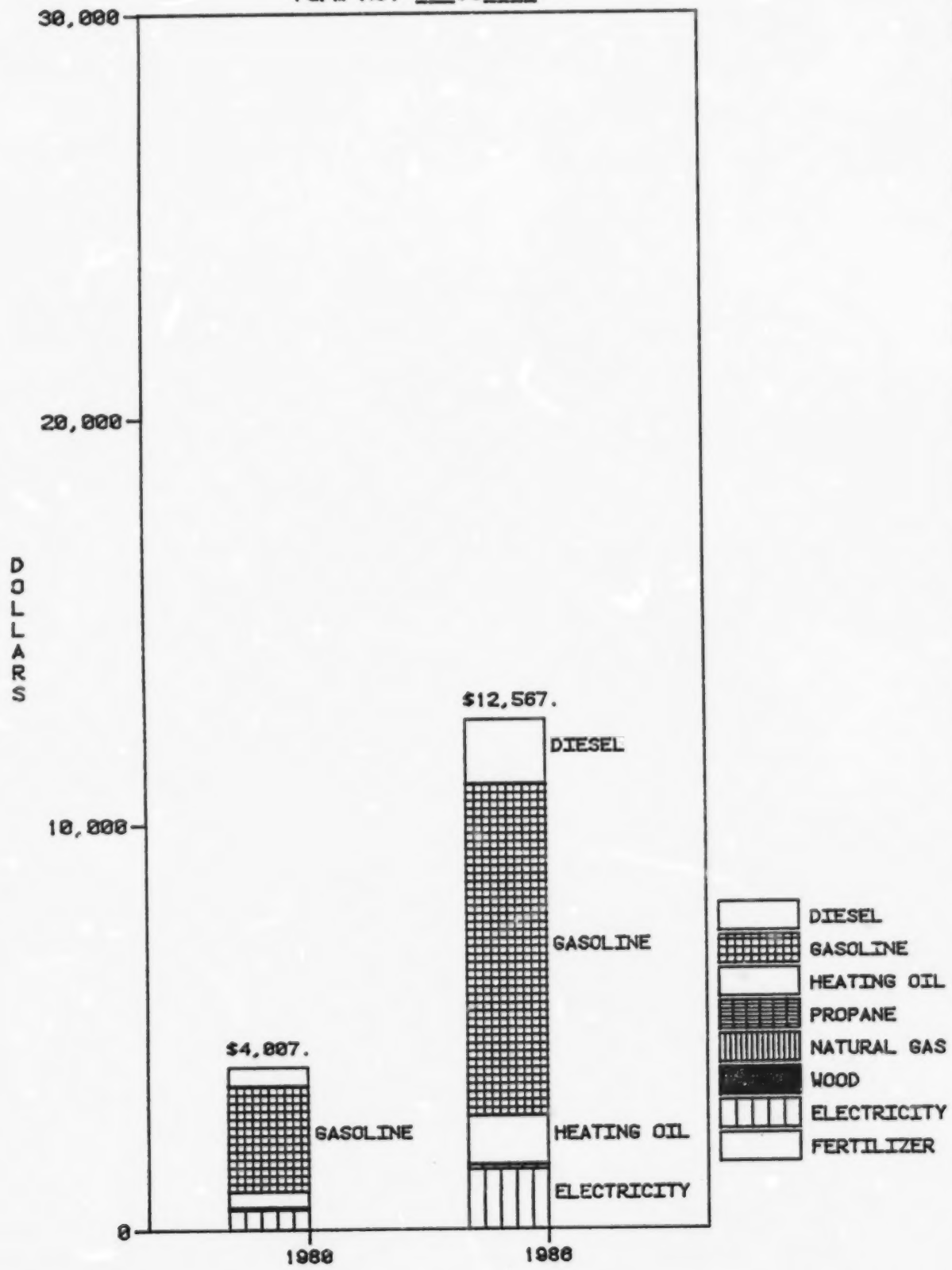


Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. ___19____



FARM 20

FARM INVENTORY:	YEAR 1981	
REGION:	WEST CENTRAL	
SOIL ZONE:	BROWN	
SOIL TYPE:	REGINA CLAY	
TOPOGRAPHY:	LEVEL	
TOTAL AREA:	640 ACRES	259 HECTARES
CULTIVATED AREA:	640 ACRES	259 HECTARES

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME	1980	3000 SF 279 m^2

This is a grain farm operated as a sole-proprietorship. Mostly wheat, barley and canary seed are raised on a three-year rotation.

- broadcast nitrogen plus 11-51-0 at 40 lbs/acre
- seeds with a discer
- weed control: Avadex liquid
  estamine + Banvel
- summerfallowing: Discer x 1 + rodweed x 3
- presently on NRC house efficiency study (natural gas use in the new farm home is being monitored).
- farm yard has close proximity to grain market and bulk fuel dealer.
- operator works off the farm.

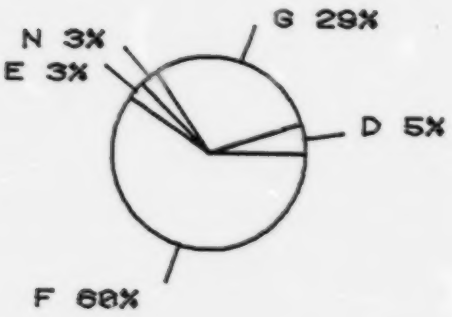
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Analyze transportation energy use.
2. Analyze the energy efficiency of moisture management and fertilizer program.
3. Arrange an energy audit of the farm home by the Saskatchewan Research Council Housing Group.

FARMER'S ESTIMATED DISTRIBUTION

Year 1980 Farm No. 20 Energy Cost $ 9,223. Total Expenses $ 55,190.

Energy Cost By Fuel

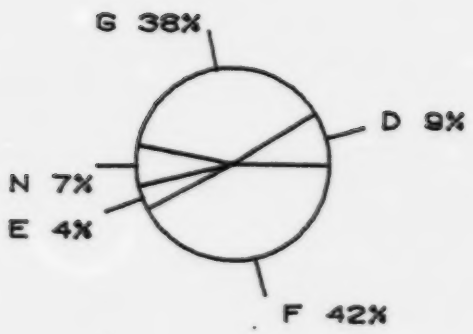


D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

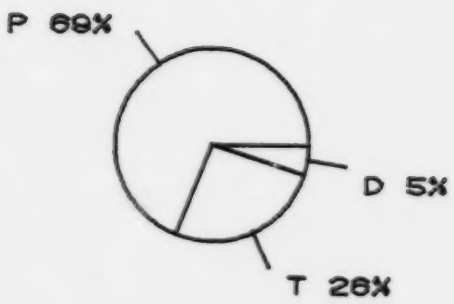
Energy Cost As Percentage Of Total Expenses

D = Direct Energy
E = Embodied Energy
O = Other

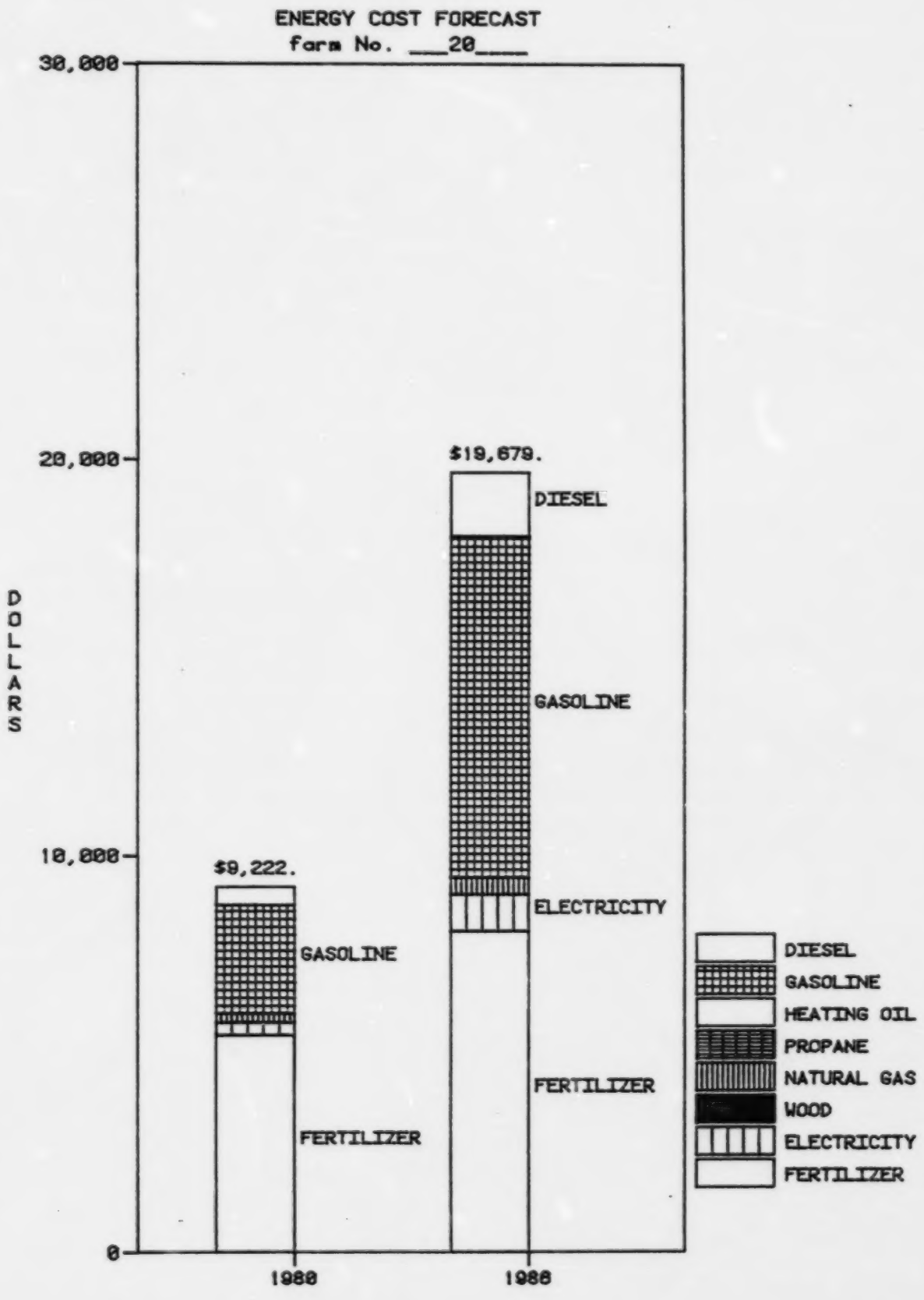
P = Production
T = Transportation
D = Domestic



Energy Content By Fuel



Energy Cost By Sector


ENERGY COST FORECAST
farm No. ___20____
30,000
20,000
10,000
0
DOLLARS
$19,679.
DIESEL
GASOLINE
ELECTRICITY
FERTILIZER
$9,222.
GASOLINE
FERTILIZER
1980
1988
DIESEL
GASOLINE
HEATING OIL
PROPANE
NATURAL GAS
WOOD
ELECTRICITY
FERTILIZER

FARM 21

FARM INVENTORY:	YEAR 1981	
REGION:	WEST CENTRAL	
SOIL ZONE:	BLACK	
SOIL TYPE:	OXBOW LOAM	
TOPOGRAPHY:	ROLLING	
TOTAL AREA:	1920 ACRES	778 HECTARES

	ANIMAL	NUMBER
TOTAL LIVESTOCK:	MILK COWS	60
	CALVES	8
	FEEDERS	10

	ANIMAL	NUMBER
BREEDING STOCK:	DAIRY COWS	60

	TYPE	YEAR BUILT	HEATED AREA
HEATED BARNS AND SHOPS:	MILK PARLOR	0	1152 SF 107 m^2

	TYPE	YEAR BUILT	HEATED AREA
HOMES:	FARM HOME*	1976	952 SF 88 m^2

This farm is a two-man dairy-grain operation. The grain enterprise produces barley, canola and silage on a 3-to 4-year rotation.

- fertilizer with 50 lb of 11-48-0 and 100 lb of nitrogen as per soil tests.
- weed control: Avadex, Treflan + 2,4-D.

Manure from the dairy is stored for 7 months. It is analyzed, spread and immediately incorporated as per test recommendations.

---

* Electrically heated. Meters to be installed in 1982 will measure space heating separate from other electricity use on this dairy farm.

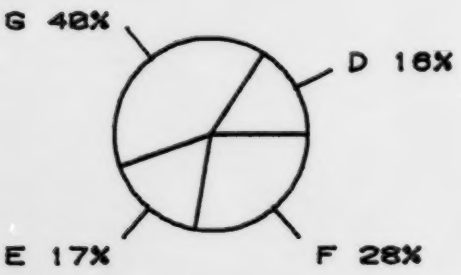
SPECIFIC RECOMMENDATIONS FOR ENERGY CONSERVATION

1. Arrange an energy audit of the dairy barn by the Office of Energy Conservation energy bus.
2. Investigate the practicality of a methane digester.
3. Analyze transportation efficiency (consider propane conversion).

FARMER'S ESTIMATED DISTRIBUTION

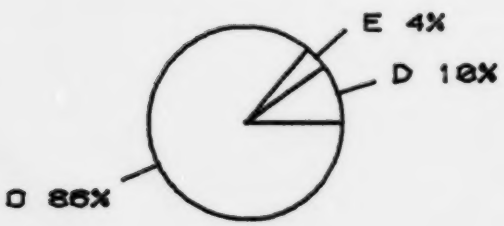
Year 1980 Farm No. 21 Energy Cost $ 22,965. Total Expenses $ 170,687.

Energy Cost By Fuel



D = Diesel
G = Gasoline
H = Heating Oil
P = Propane
N = Natural Gas
W = Wood
E = Electricity
F = Fertilizer

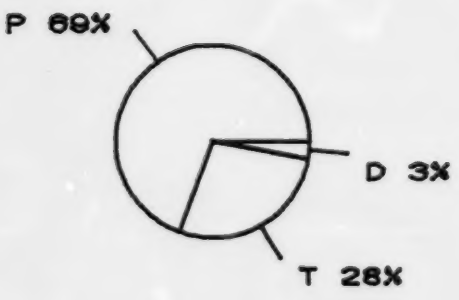
Energy Cost As Percentage Of Total Expenses



D = Direct Energy
E = Embodied Energy
O = Other

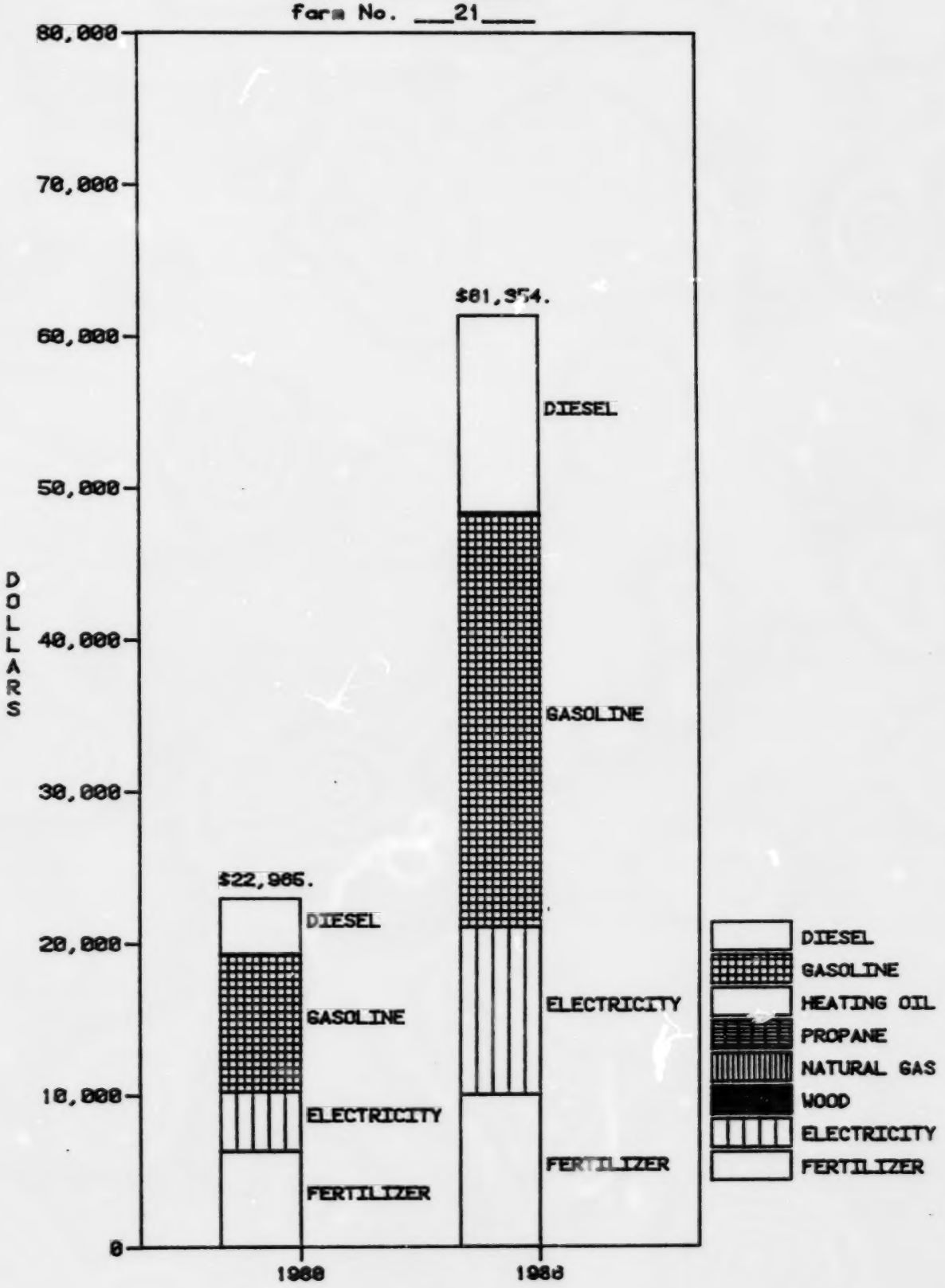
P = Production
T = Transportation
D = Domestic

Energy Content By Fuel



Energy Cost By Sector

ENERGY COST FORECAST
farm No. ___21____



APPENDIX B

ENERGY AUDIT FORMS

Energy Audit Forms

Collection of reliable data on farm energy consumption has been discussed in previous reports (e.g. Gimby & Coxworth, 1981). The audit forms used in this project, illustrated here, were developed by reviewing inventory formats used in previous studies, particularly Coxworth & Thompson, 1978, and Jensen, 1977. Other farm audits available from various agencies throughout Canada and the U.S.A. were also studied.

The energy audit form is designed to serve three purposes:

1. To summarize the amounts and costs of energy inputs for a selected year of farm operation.
2. To assemble an inventory of energy-using equipment on the farm.
3. To describe the farming operation in sufficient detail to determine the main functions for which energy is consumed.

This information provides the starting point for energy managament recommendations to each farmer. It is recognized that most farmers do not know exactly how much energy is consumed for a particular task on their farm. Information collected in the initial audit will identify the level of monitoring necessary on each farm to obtain more reliable data concerning the distribution of energy use.

If available, sufficient data is collected to estimate the efficiency of energy use for specific tasks on each farm. When comparisons reveal wide discrepancies from "average" requirements, the farmer will be asked for more detailed information concerning his energy use in that particular area. In this way it will be possible to identify energy end-uses on the farm which could be made more efficient. This type of analysis will become possible for any farm in Saskatchewan once sufficient baseline data has been accumulated.

Energy consumption will also be calculated on the basis of farm production output. This will permit comparison of energy efficiency among various farmers producing the same product(s). For example, a farmer will be able to compare his energy costs per tonne of grain to the energy costs incurred by other farmers with similar climatic and soil conditions.

Previous experience of the project team has shown that audit forms must be continually improved as they are used, to develop a format that is easy to complete and provides the necessary information. A requirement of this project is to develop an audit format compatible with any farm in Saskatchewan, so that it can be used either directly by the farmer or with guidance from local extension personnel from Saskatchewan Agriculture.

FARM ENERGY AUDIT *

NAME _____

ADDRESS _____

_____

TELEPHONE _____

LAND LOCATION:

_____ OF _____ TWP. _____ R. _____ W. ___

TYPE OF FARM _____

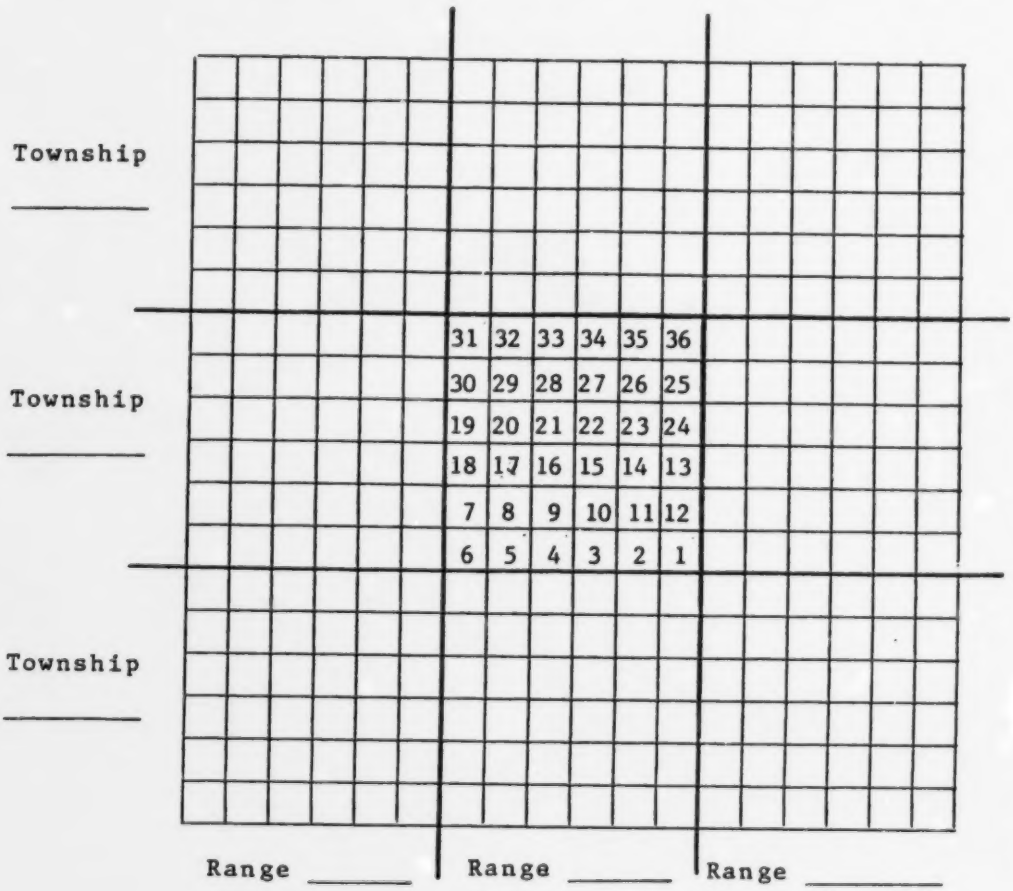
CONDUCTED BY _____

DATE _____

* The name, address, and land location is kept confidential and not reported to others without the farmer's written permission.

FARM LOCATION

1. Mark all land farmed by project member.
2. Mark headquarters.



Soil Classification _____

Topography _____

INTRODUCTION

The Farm Energy Audit consists of three sections:

PART I - SUMMARY AND DISTRIBUTION OF DIRECT ENERGY INPUTS.

- FORECAST ENERGY COSTS.

PART II - INVENTORY OF ENERGY - USING EQUIPMENT.

PART III - ENERGY END-USE

- PRODUCTION METHODS AND FACILITIES.

SUMMARY OF DIRECT ENERGY COSTS

ENERGY TYPE	1980	1981	MAIN USES
	Amount x Price = Cost	Amount x Price = Cost	
Gasoline	_____ x ____ = _____	_____ x ____ = _____	
	_____ x ____ = _____	_____ x ____ = _____	
Diesel Fuel	_____ x ____ = _____	_____ x ____ = _____	
	_____ x ____ = _____	_____ x ____ = _____	
Oil and grease			
Heating Oil	_____ x ____ = _____	_____ x ____ = _____	
Propane	_____ x ____ = _____	_____ x ____ = _____	
Natural Gas	_____ x ____ = _____	_____ x ____ = _____	
Electricity	_____ x ____ = _____	_____ x ____ = _____	
Total Cost			

Use farm records to add up total energy consumption and costs in 1980 and 1981.

PART II - INVENTORY OF ENERGY-USING EQUIPMENT

INSTRUCTIONS

1. For each energy type, list equipment specifications and estimated annual usage.

FARM ENERGY DISTRIBUTION: HEATING OIL

	HOME		SHOP		BARNS	
Specifications of Heating Units						
Make and Model						
Age (approx.)						
Rated Input (BTU)						
Rated Output (BTU)						
Date of last servicing						
NOTES						

FARM ENERGY DISTRIBUTION: PROPANE

	HOME		SHOP		BARNS	
Specifications of Heating Units						
Make and Model						
Age (approx.)						
Rated Input (BTU)						
Rated Output (BTU)						
Date of last servicing						
NOTES						

FARM ENERGY DISTRIBUTION: NATURAL GAS

	HOME		SHOP		BARNS	
Specifications of Heating Units						
Make and Model						
Age (approx.)						
Rated Input (BTU)						
Rated Output (BTU)						
Date of last servicing						
NOTES						

FARM ENERGY DISTRIBUTION: ELECTRICITY

	HOME	SHOP	FARMSTEAD	BARNS
LIGHTS				
SPACE HEATERS				
WATER HEATERS				
EQUIPMENT				
TOTAL				

INSTRUCTIONS: Calculate total wattage of major electrical items in each category.

FARM ENERGY DISTRIBUTION: GASOLINE

POWERED EQUIPMENT	MAKE, MODEL, YR. & SIZE	ENGINE	ESTIMATED USE PER YEAR (MILES/HOURS)*	MAIN USES
CARS				
TRUCKS				
TRACTORS				
SWATHERS				
COMBINES				
OTHER				

* Or kilometres (specify)

FARM ENERGY DISTRIBUTION: DIESEL FUEL

POWERED EQUIPMENT	MAKE, MODEL, YR. & SIZE	ENGINE	ESTIMATED USE PER YEAR (MILES/HOURS)*	MAIN USES
CARS				
TRUCKS				
TRACTORS				
SWATHERS				
COMBINES				
OTHER				

* Or kilometres (specify)

PART III - PRODUCTION METHODS AND FACILITIES

INSTRUCTIONS

1. Describe farming operations, production inputs and outputs, building specifications, etc.

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FARMSTEAD PLAN

N

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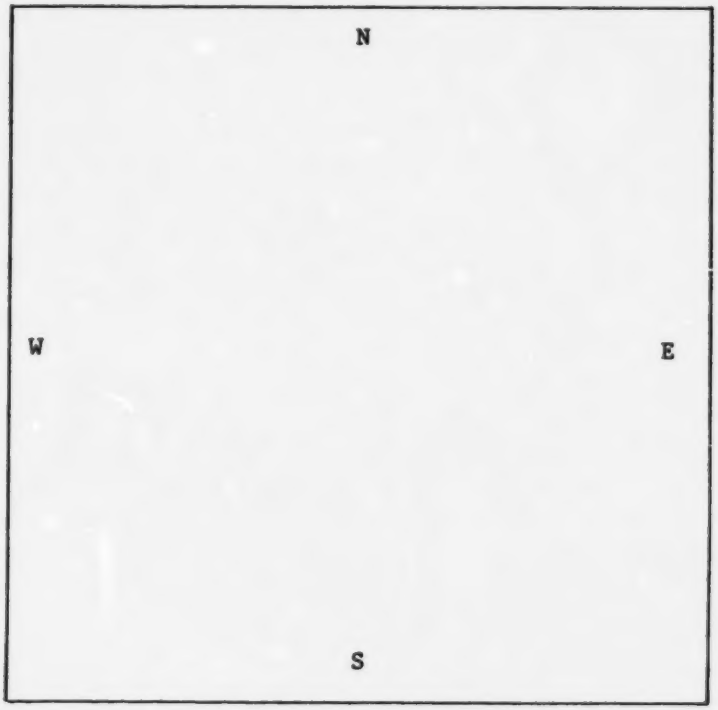
Instructions

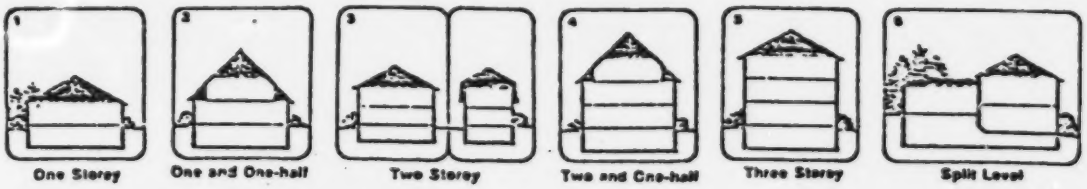
1. Sketch the location of buildings, utilites, roads, etc.

HOME PLAN

1. Sketch the floor plan with approximate dimensions of all heated areas. Show windows and doors.



2. Indicate the style of home below:



3. Approximate age _____
4. Wall construction _____
5. Insulation: Walls _____
   Ceiling _____
   Basement _____
6. No. of occupants: Adults _____ Children _____
7. Thermostat settings: Day _____ Night _____

CROP PRODUCTION

Crops in 1981	Acres	Fertilizer		Herbicides		Seeding Rate	Yield
		Formulation	Rate	Formulation	Rate		
a) on stubble							
b) on summerfallow							
c) other							

Factors which increased or decreased yields compared to "normal" year: _____

_____

_____

_____

Tillage-Seeding Operations	Implement Size	Tractor Engine HP	Diesel or Gas	Acres Per Hour	Gallons* Per Hour	Times Over	Gallons* Per Acre
a) On stubble							
b) On summerfallow							
c) Summerfallowing							
d) Spraying							
Acres							

* or litres (specify)

Harvesting	Equipment Size	S.P. or P.T.O.	Engine H.P.	Diesel or Gas	Acres Per Hr.	Gallons* Per Hr.	Gallons* Per Acre
a) Swathing	_____ ft.	_____	_____	_____	_____	_____	_____
	_____ ft.	_____	_____	_____	_____	_____	_____
b) Combining	_____ inches	_____	_____	_____	_____	_____	_____
	_____ inches	_____	_____	_____	_____	_____	_____

Hauling	Truck Size	Round-trip Miles+ Per Load	Engine H.P.	Diesel or Gas	Total Miles+ Per Year	Miles+ Per Gal.	Gallons* Per Year
a) combine to farm storage	_____	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____	_____
b) Combine to elevator	_____	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____	_____
c) farm storage to elevator	_____	_____	_____	_____	_____	_____	_____
	_____	_____	_____	_____	_____	_____	_____

* or litres (specify)

\+ or kilometres (specify)

IRRIGATION

Crops Irrig'd.	Area Irrig'd.	Type of System	Total Depth of Water Applied	Pump Specs.	Motor Specs.	Pressure at Pump	Suction Lift	Flow Rate	Pipe Size(s)	Hours Operated	Energy Used per Season

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1. Water source _____
2. Soil Types _____
3. How is irrigation scheduled? _____
4. NOTES:

_____

_____

_____

GRAIN DRYING

1. Dryer make and model _____
2. Dryer type _____
3. Fuel _____ BTU rating _____
4. Fan horsepower _____ Flow rate _____
5. Driven by _____
6. Dryer holding capacity _____
7. Grain Dried In 1981
   a) _____ bushels of _____ from _____% to _____%
      Drying air temperature _____
      Outside air temperature _____
      Drying rate _____ bu. per hour.
   b) _____ bushels of _____ from _____% to _____%
      Drying air temperature _____
      Outside air temperature _____
      Drying rate _____ bu. per hour.
   c) _____ bushels of _____ from _____% to _____%
      Drying air temperature _____
      Outside air temperature _____
      Drying rate _____ bu. per hour.
8. NOTES

_____

_____

_____

_____

_____

LIVESTOCK PRODUCTION

1. Type of livestock _____
2. Production per year _____
3. Describe housing system:

4. Feed consumption per year
   a) grown on farm _____
   b) purchased _____
5. Equipment used for feed delivery and collection:

   _____

   _____

   _____

   _____

   Average hauling distance _____
6. Equipment used for feed processing:

   _____

   _____
7. Equipment used for feed distribution

   _____

   _____
8. Trucks used for handling livestock and/or product

   _____

   _____

   Average hauling distance* _____

_____

* (specify whether reporting miles or kilometres).

MANURE HANDLING

1. Livestock _____ No. _____ Average Weight _____
2. Type of manure storage _____
3. Holding time _____
4. When is manure spread? _____
5. Equipment used _____
6. Hauling distance _____
7. Area covered _____
8. Estimated application rate _____
9. Is manure worked in directly after spreading? _____
10. Crops grown on manure _____
11. Fertilizer type and rates on manured fields _____
    _____
12. Are soil test results available? (Summarize below) _____
    _____
    _____
13. Has manure been analyzed? (Summarize below) _____
    _____
    _____
14. Crop response to manure?
    Good _____ Fair _____ Unpredictable _____
15. Notes and comments
    _____
    _____
    _____
    _____
    _____
16. Weed problems with use of manure?

APPENDIX C

The following news release from the University of Saskatchewan outlines the FarmLab program.

university news

NEWS AND PUBLICATIONS ● 20 EDUCATION BUILDING ● UNIVERSITY OF SASKATCHEWAN, SASKATOON, S7N 0W0 ● PHONE 343 3756

(ADVANCE FOR RELEASE AT 1:00 P.M. CST, THURSDAY, MAY 28)

(ADVANCE)...SASKATOON, MAY 28 - Dr. Leo Kristjanson, president of the University of Saskatchewan, said today that the province's new FarmLab program will strengthen the historic co-operation among campus researchers, government extension staff, and farmers.

"We have long prided ourselves on the usefulness and value of our agricultural research which, through the new program, will be incorporated into typical farm operations much more rapidly than would otherwise be possible."

Dr. Kristjanson was speaking at a news conference in Saskatoon at which the agreement covering the five-year FarmLab was signed by representatives of the University and the Saskatchewan Government. Under it, the University will receive a substantial part of a $25 million commitment for research aimed at enabling the agriculture industry to meet the food demands of the next decade, and extension personnel and farmers will co-operate with the researchers to ensure that the results of their studies are put into practice. The program will also provide opportunities for training the skilled manpower that will be needed to sustain the agriculture industry in the future.

Dr. Kristjanson said he is delighted the Saskatchewan Government, through its Department of Agriculture, is making a sincere effort to meet the urgent need for more research in agriculture.

"The prospects for increased grain sales over the coming decade require that the scientific expertise in crop production, and particularly in soil management,

(ADVANCE)..... MORE

be improved. FarmLab will enable our agricultural researchers to undertake a much needed expansion of their activities and strengthen work now going on in soils and water management and in several other aspects of crop production. In addition, such new areas as toxicology and biotechnology, in which we have had difficulty obtaining funding, will receive the attention they deserve."

Dr. Kristjanson noted that the University will receive up to $3.2 million during 1981-82. Some of this will be for research already under way.

The money will finance research related to soil and water management, including a new productive system based on zero and minimum tillage, techniques for handling nitrogen, the development of a soil salinity clinic, and methods of managing snow and increasing the amount of moisture it provides for crop growth; the development of integrated systems of weed control through cultivation, crop rotation, and other practices that depend minimally on herbicides; increased plant breeding programs and grain variety testing, including the use of tissue culture techniques for the more rapid improvement of important field crops; trace mineral and vitamin deficiences in livestock; the evaluation of Saskatchewan forages, grains and by-products for use by dairy and beef cattle; animal reproductive efficiency, including earlier breeding; the measurement and control of toxic substances in plants, soils and animals; the use of biotechnology to find a new biological control for insect pests; and economic analyses related to crop and animal production.

The research program is expected to require the appointment of about a dozen scientists as well as additional technical personnel, and will provide employment opportunities for graduate students.

(END ADVANCE FOR RELEASE AT 1:00 P.M., CST, THURSDAY, MAY 28)